RVM 1 HYDROELECTRIC POWER (PTY) LTD

RIEMVASMAAK HYDROPOWER PROJECT, ORANGE RIVER, NORTHERN CAPE PROVINCE, SOUTH AFRICA

ENVIRONMENTAL IMPACT ASSESSMENT
VOLUME 3: AMENDED FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT

DEA Reference Number: 14/12/16/3/3/2/600
NEAS Reference Number: DEA/EIA/0002013/2013

Prepared for:	Prepared by:
RVM1 HYDRO ELECTRIC POWER (Pty) Ltd Registration No. 2011/135598/07	EOH
RVM1 Hydro Electric Power	**EOH Coastal & Environmental Services**
Loft Office No. 6 The Woodmill Lifestyle Centre Vredenburg Road Stellenbosch South Africa	Grahamstown P.O. Box 934, Grahamstown, 6140 South Africa

AMENDED FINAL REPORT

JUNE 2016

EOH Coastal & Environmental Services

Report Title: Amended Final Environmental Impact Assessment Report
Report Version: Amended Final Report – June 2016
Project Number: 279

Name	Responsibility
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Ted Avis	Author
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Distribution

Distributed to	Hard	Electronic
Department of Environmental Affairs, Pretoria	4	5

Distributed to	Electronic
Northern Cape Department of Environment and Nature Conservation	
Kimberley Office	1
Upington Office	1
DWS Northern Cape	
Kimberley Office	1
Upington Office	1
SANParks	
Pretoria Groen Kloof Office Park Planning & Development Conservation Services Division	1
Augrabies Falls National Park	1
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DAFF Upington	1
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Eskom	1
Department of Energy	1
Department of Mineral Resources	1
Department of Rural Development and Land Reform	1
National Energy Regulator	1
SAHRA	Upload
SKI	1
Telkom	1
Snitch	1
Kakamas Water User Association	1
Rooipad Farmers Association	1
Blouputs Farmers Association	1
Marchant Farmers Association	1
Augrabies Farmers Association	1
Kakamas Farmers Association	1
Schroeder Farmers Association	1
Mr Kobus van Coppenhagen	1
Ngwao-Boswa Ya Kapa Bokone (Northern Cape Provincial Heritage Resources Authority)	1
TOTAL	30

REPORTS PRODUCED AS PART OF THIS EIA:

Volume 1: Environmental Scoping Report
Volume 2: Specialist Reports
Volume 3: Amended Final Environmental Impact Assessment Report
Volume 3a: Appendices to Environmental Impact Assessment Report
Volume 4: Environmental Management Programme
Volume 5 Comment and Response Report
Volume 6 Addendum to Amended EIA Report

Notes:

(i) The Environmental Scoping Report was produced by Aurecon and accepted by DEA in October 2013
(ii) Volume 2 was compiled by EOH Coastal & Environmental Services
(iii) Volumes 3, 4, 5 and 6 were prepared by EOH Coastal & Environmental Services

LIST OF ACRONYMS

AFNP	Augrabies Falls National Park
AGIS	Agricultural Geo-referenced Information System
AIDS	Acquired Immune Deficiency Syndrome
amsl	Above Mean Sea Level
As	Arsenic
CBA	Critical Biodiversity Area
CBNRM	Community Based Natural Resource Management
CES	Coastal & Environmental Services
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLO	Community Liaison Officer
CMMC	Community Management and Monitoring Committee
CR	Critically Endangered Species
Cr	Chromium
DM	District Municipality
DMR	Department of Mineral Resources
DoE	Department of Energy
DRE	Diversity Rarity and Endemism
DWA	Department of Water Affairs (now DWS)
DWAF	Department of Water Affairs and Forestry (now DWS)
DWS	Department of Water and Sanitation
EA	Environmental Assessment
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIS	Ecological Importance and Sensitivity
EMPr	Environmental Management Programme
EN	Endangered Species
ESA	Ecological Support Area
ESIA	Environmental and Social Impact Assessment
FRAI	Fish Response Assessment Index
GC	Gariep Centre (of endemism)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GWh	Gigawatt-hours
ha	Hectare
HEP	Hydro Electric Power
HPP	Hydroelectric power project

HV	High Voltage
I&AP	Interested and Affected Party
IBA	Important Bird Area
IDP	Integrated Development Plan
IEP	Integrated Energy Plan
IFC	International Finance Corporation
IHI	Index of Habitat Integrity
IPAP	The South African Industrial Policy Action Plan
IRCA	International Register of Certificated Auditors
IRP	Integrated Resource Plan
IUCN	International Union for Conservation of Nature
LED	Local Economic Development
LM	Local Municipality
LOHEPS	Lower Orange Hydroelectric Power Scheme
LSA	Late Stone Age
LTMS	Long Term Mitigation Scenarios
MIRAI	Macro-invertebrate Response Assessment Index
MSA	Middle Stone Age
MSK	Melkbosrandsamewerkingskomitee
MW	Megawatt
N/A	Not Applicable
NDBSP	Namakwa District Biodiversity Sector Plan
NDP	National Development Plan
NE	Near Endangered
NEMA	National Environmental Management Act
NEM: BA	National Environmental Management: Biodiversity Act
NEM: PAA	National Environmental Management: Protected Areas Act
NPAES	National Protected Areas Expansion Strategy
NSD	Noise Sensitive Development
NT	Near Threatened
ORASECOM	Orange-Senqu River Commission
PACs	Project-Affected Communities
PES	Present Ecological State
PICC	Presidential Infrastructure Coordinating Committee
PNCO	Provincial Nature Conservation Ordinance
PPA	Power Purchase Agreement
QDS	Quarter Degree Square
RAP	Resettlement Action Plans
RCT	Riemvasmaak Community Trust
REC	Recommended Ecological Category
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RFP	Request for Qualification and Proposals

RVM	Riemvasmaak
SA	South Africa
SAHRA	South African Heritage Resources Agency
SANBI	South African National Biodiversity Institute
SANParks	South Africa National Parks
SARI	The South African Renewables Initiative
SCC	Species of Conservation Concern
SDEMF	Siyanda District Environmental Management framework
SEBS	Socio-Economic Baseline Study
SIA	Social Impact Assessment
SIP	Strategic Infrastructure Projects
SMME	Small, Medium and Micro Enterprises
SMP	Social Management Plan
TB	Tuberculosis
TDS	Total Dissolved Solids
UNESCO	The United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VEGRAI	Vegetation Response Assessment Index
VU	Vulnerable Species

FOREWORD TO THE AMENDED FINAL EIA REPORT

On 9th December 2015[1] the Department of Environmental Affairs (DEA) wrote to EOH Coastal and Environmental Services (CES) and rejected the September 2015 Environmental Impact Assessment Report for the proposed 40MW Riemvasmaak Hydropower Project on the Orange River near the Augrabies Falls.

The rejection letter, which is reproduced in full below, required additional information to enable the department to make a properly-informed decision on the application for environmental authorisation.

The information required by the department falls under five main headings, summarised as follows:

DEA paragraph	**Summarised requirement**
a) – Rejection Letter page 1	Comments from Birdlife South Africa
b) – Rejection Letter pages 1-2	Justification for the proposed flow rate of 30m^3/sec
c) – Rejection Letter page 2	Impact of low flows on tourism
d) – Rejection Letter page 2	Employment opportunities
e) to h) - Rejection Letter pages 2-3	Approval of EIA Report by SANParks

Much of the information required by DEA in the rejection letter was already in the Final EIA Report. However, instead of attempting to make fragmented and piecemeal revisions to the text of the Final EIA Report, which would almost certainly cause confusion among I&APs rather than clarifying issues, it was considered prudent to prepare an Addendum to the Final EIA Report that focuses on the department's exact requirements. Accordingly each of the department's requirements tabulated above is addressed in Chapters 1 to 5 of the Addendum Report, which is Volume 6 of the suite of documents that comprise the EIA report (see page iii above).

Chapter 6 of the Addendum Report addresses the final sentence of paragraph f) of the rejection letter – *All matters raised in in the acceptance letter dated 30th October 2013 of the final scoping report, must be adhered to in full and must be included in the amended EIAR*. These issues were addressed in the Foreword to the Final EIA Report (see below), but a review of the information presented indicated that a few of the issues had not been fully addressed, and additional detail is therefore provided in the Addendum Report.

The table following DEA's rejection letter indicates where amendments have been made to the September 2015 Final EIA Report, as a result of issues raised by DEA in the rejection letter, and also as a result of comments received from I&APs on the Draft for Comment version of the Amended Final EIA Report.

The table also provides a brief overview of the matters addressed in the Addendum Report.

With regard to the requirement that the Amended Final EIA Report be submitted to SANParks "*to obtain their approval, with or without conditions*", it is important to note that, in a letter dated 2nd June 2016 to the applicant, SANParks stated that it " i*ntends not to provide written approval for the development of the weir, canal and a portion of the power line as part of the proposed hydro-power station within the Augrabies Falls National Park …* ". The full text of the letter is reproduced below.

Notwithstanding SANParks' refusal to approve the development, the Amended Final EIA Report, this Addendum Report and the Economic Assessment will be submitted to DEA, since it is that department's mandate to assess an application for an environmental authorisation and make a decision to issue an environmental authorisation or to refuse to do so.

[1] The letter was dated 09 / 11 / 2015, but on enquiry by the EAP, DEA acknowledged that this was an error, and confirmed that the date of signature was 9th December 2015.

Letter from SANParks to the applicant, 2nd June 2016

To develop and manage a system of national parks that represents the biodiversity, landscapes, and associated heritage assets of South Africa for the sustainable use and benefit of all.

South African NATIONAL PARKS

Ref#: 16/1/4

16 May 2016

MR JCD THERON
Director: RVM 1 Hydro Electric Power (Pty) Ltd
STELLENBOSCH
7600
Tel.: 021 934 5501
Fax: 086 520 8648

Email: niel@hydro-sa.com

Dear Mr Theron,

THE PROPOSED AUGRABIES HYDRO POWER STATION PROJECT

Your letter dated 29 April 2016 refers.

In respect of SANParks response below, your proposed meeting request has reference:-

1.1 SANParks is of the view that the RVM 1 Hydro Electric Power (Pty) Ltd and its representatives could meet with SANParks Executive Management.

1.2 The outcomes of the above would determine the necessity of a possible meeting with the SANParks Board.

1.3 A date for such a meeting between the RVM 1 Hydro Electric Power (Pty) Ltd and its representatives and SANParks Managing Executive should be agreed between the parties.

As in the same Riemvasmaak Gemeenskap Ontwikkelingstrust, I hereto submit in respect of SANParks position to this effect:-

a. SANParks supports renewable energy generation traditionally provided by technologies such as hydro, wind, solar and biogas;

b. Insofar this project, SANParks does not support the construction of the weir, canal and a portion of the power line within the Augrabies Falls National Park;

addo elephant
agulhas
augrabies falls
bontebok
golden gate highlands
karoo
kgalagadi transfrontier
knysna lake area
kruger
mapungubwe
marakele
mountain zebra
namaqua
table mountain
tankwa-karoo
tsitsikamma
ai-ais/richtersveld
vaalbos
west coast
wilderness

643 Leyds Street
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P.O. Box 787
PRETORIA
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Tel: 012 426-5000

central reservations: 012 428 9111
reservations@sanparks.org
www.sanparks.org

c. For example, the area of the park through which the canal is planned is currently zoned Remote and falls in the special management area category. The Remote zone according to the zonation plan of the Augrabies Falls National Park is the zone providing the highest form of protection. This is an area retaining an intrinsically wild appearance and character, or capable of being restored to such and which is undeveloped. There are no permanent improvements or any form of human habitation. It provides outstanding opportunities for solitude with awe inspiring natural characteristics. If present at all, sight and sound of human habitation and activities are barely discernable and at a far distance. The zone also serves to protect sensitive environments from development impacts and tourism pressure. The conservation objective is to maintain the zone in as near to a natural state as possible with no impact on biodiversity pattern or processes. Existing impacts on biodiversity, either from historical usage or originating from outside the zone should be mitigated. It must be noted that amendments to the management plan and zoning have to be approved by the Minister of the Department of Environment Affairs. The revision of an approved Park Management Plan is the prerogative of the Minister in accordance to NEM:PAA Section 40 (2). Any the change of a particular zone within a National Park is subject to Section 41 (g) of the same Act compelling SANParks to change such zones with predetermined conservation objectives and activities for all the national parks in the country to allow for the proposed project. Further to this, the proposal to divert a sizable portion of the river's flow from the Augrabies waterfall would have a negative impact on the visitor experience to the falls, especially during the low flow periods;

d. SANParks communicated its concerns through the public meetings and correspondence to the previous environmental consultants and to EOH Coastal & Environmental Services timeously. Section 50 (2) of the National Environmental Management: Protected Areas Act No. 57 of 2003 confirms that "An activity allowed in terms of subsection (1) (a) or (b) may not negatively affect the survival of any species in or significantly disrupt the integrity of the ecological systems of the national parks, nature reserve or world heritage site.";

e. For this reason, and not limited to the above only, SANParks intends not to provide written approval for the development of the of the weir, canal and a portion of the power-line as part of the proposed hydro power station within the Augrabies Falls National Park in accordance to Section 50 (5) of the National Environmental Management: Protected Areas Act No. 57 of 2003 which stipulates "No development, construction or farming may be permitted in a national park, nature reserve or world heritage site without the prior written approval of the management authority". SANParks furthermore does

not support the development of the proposed hydro power station at this specific location as it would impact on the flow of water over the falls which would have a negative impact visitor's experience and sense of the place of the Augrabies Fall National Park.

In anticipation that this letter is received in order, it will allow SANParks to optimally manage Augrabies Falls National Parks for its unique representative part of the South African landscape and biodiversity conservation for the benefit and enjoyment of future generations.

Yours sincerely

Mr Fundisile Mketeni
Chief Executive Officer
South African National Parks
2 June 2016

Cc: **Mr. Sibusiso Mthembu, Director: Integrated Environmental Authorisations**
SLMthembu@environment.gov.za

Dr. Geoff Cowan, Director: Protected Areas and Planning
gcowan@environment.gov.za

DEA's rejection letter, dated 9th November 2015 (sent to the EAP on 9th December 2015)

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

Private Bag X 447· PRETORIA · 0001· Environment House · 473 Steve Biko Road, Arcadia,· PRETORIA
Tel (+ 27 12) 399 9372

DEA Reference: 14/12/16/3/3/2/600
Enquiries: Mr Vincent Chauke
Telephone: (012) 399 9399 **E-mail:** vchauke@environment.gov.za

Dr Ted Avis
EOH Coastal & Environmental Services
P.O. Box 934
GRAHAMSTOWN
6140

Telephone number: (046) 622 2364
Email address: ted.avis@cesnet.co.za

PER EMAIL / MAIL

Dear Dr Avis

REJECTION OF ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED 40MW HYDROPOWER STATION ON THE FARM RIEMVASMAAK, THE REMAINDER OF FARM NO 497 AND PORTION 1 OF FARM NO 498, ON THE ORANGE RIVER IN THE VICINITY OF AUGRABIES FALLS NATIONAL PARK, GARIB LOCAL MUNICIPALITY, NORTHERN CAPE PROVINCE

The final Environmental Impact Assessment Report (EIAR) dated September 2015 and received by the Department on 05 October 2015, refers.

Based on a review of the final Environmental Impact Assessment Report (EIAR) dated September 2015, please be advised that this Department, in terms of Regulation 34 (2) (b), is not able to make an informed decision on the abovementioned application and an amended EIAR needs to be submitted.

This Department draw your attention to the following comments and issues that must be addressed in the amended EIAR prior to decision making:

a) Comments dated 05 June 2015 from the Department of Environment and Nature Conservation (DENC) indicates that, the proposed development site is located within an Important Bird Area (IBA) as identified by BirdLife South Africa and also falls within the Gariep Centre of Endemism. The Environmental Assessment Practitioner (EAP) managing the application failed to identify BirdLife South Africa as a crucial stakeholder who should comment on this application. Comments from BirdLife South Africa must be obtained and it must be included in the amended EIAR.

b) The final Environmental Impact Assessment report dated September 2015 indicates that a **30m³/s** is seen as an **accepted** flow rate over the Augrabies falls. Please include documentation indicating how this value was arrived at and how it was scientifically proven also taken into consideration the ecological reserve. This must be included in the amended EIAR. This value of **30m³/s** is also an important value for SANParks and therefore this department needs proof that this value of **30m³/s** was discussed and agreed

upon with SANParks as the management authority of Augrabies Falls National Park. This must be included in the amended EIAR.

c) The Socio-Economic Impact Assessment report as included in the Environmental Impact Assessment report dated September 2015 concluded that the proposed 40MW Hydropower project will not have a noticeable effect on the falls and tourism during floods. The study failed to indicate the effects of the proposed 40MW Hydropower project during low flow and drought periods (of which it is the case for a large part of the year) on the falls, as well as on the tourism. The Department requires the specialist study to be amended to include the effects of the proposed 40MW Hydropower project on the falls and the tourism during low flow and drought periods as well as the impact this information might have on the economic viability of the proposed development should the flow in the river be low for extended periods as a result of drought conditions. This must be included in the amended EIAR.

d) The Environmental Impact Assessment report dated September 2015 indicates that the project is anticipated to provide between 150 to 200 temporary job opportunities during the construction phase, whilst between five and ten permanent job opportunities will be created during the project's operational phase. This Department requests proof of the agreement with the local community/ies and other relevant departments with regard to employment opportunities and this proof must be included in the amended final EIA report.

e) Kindly note that the acceptance letter dated 30 October 2013 of the final scoping report clearly indicated that SANPark's approval in terms of section 50 (5) of the National Environment Management: Protected Areas Act, 2003, is required and must be obtained prior to the submission of the final EIAR.

f) During the process of compiling the Environmental Impact Assessment Report, the Department responded to an email query on 19 May 2015, and advised that the final EIAR may be submitted prior to obtaining approval from the management authority i.e. SANParks. After receiving several comments in this regard from internal and external stakeholders, the Department has decided that the specific email communication was incorrect and that the acceptance letter takes preference. All matters raised in the acceptance letter dated 30 October 2013 of the final scoping report, must be adhered to in full and must be included in the amended EIAR.

g) Furthermore, the National Environment Management Act, 1998 (Act No. 107 of 1998) (NEMA) and the EIA Regulations must be read in conjunction with the National Environmental Management: Protected Areas Act, 2003 (Act No 57 of 2003), which reads as follows:

Section 50: *"Commercial and community activities in a national park, nature reserve and world heritage site".*

Section 50 (5): *"No development, construction or farming may be permitted in a national park, nature reserve or world heritage site without the prior written approval of the management authority".*

Comments on the above were obtained from the Branch: Biodiversity and Conservation Management and the Protected Areas Planning, Legislation, Compliance and Monitoring Unit in the Department. Comments dealt specifically with section 86 of the Protected Areas Regulations as stipulated in point (h) below.

h) The Protected Areas Act, 2003 (Act No. 57 of 2003), Section 86 (Regulations by Minister), stipulates the following under Part 4, Regulation 19 (1) (a) and (b), and (2):

"(1) No development contemplated in section 50(5) of the Act shall be implemented -

2

(a) In any area other than an area specifically designated for such development in a management plan; and

(b) Before a management authority has indicated in writing the nature and extent of the strategic or environmental impact assessment required for the development.

(2) No commercial activity or activity contemplated in ***section 50*** *of the Act, which requires an environmental impact assessment to be undertaken, either in terms of subregulation (1)(b) or under any other law, may be implemented before a management authority has approved, with or without conditions, the environmental impact assessment before it is submitted to the relevant authority for approval".*

In order to adhere to this Regulation, the Department requires that you submit your amended EIAR to the Management Authority for Augrabies Falls National Park, (SANParks, Groenkloof, Pretoria), to obtain their approval, with or without conditions. The amended EIAR to be submitted to this Department must include SANParks approval, signed by the CEO of SANParks, as they are the management Authority for the area in question. The amended EIAR must be circulate for notification to the I&APs for a period of 21 days. The Department will re-evaluate the final EIAR to make a decision on this application once all the above has been concluded.

This Department further advises that according to Regulation 67 of the EIA Regulations, 2010, an application in terms of the EIA Regulations lapses if the applicant, after having submitted the application, fails for a period of six (6) months to comply with a requirement in terms of the EIA Regulations relating to the consideration of the application.

You are hereby reminded of Section 24F of the National Environmental Management Act 1998 (Act No. 107 of 1998), as amended, that no activity may commence prior to an environmental authorisation being granted by the Department.

Yours sincerely

Mr Sabelo Malaza
Chief Director: Integrated Environmental Authorisations
Department of Environmental Affairs
Letter signed by: Mr Danie Smit
Designation: Deputy Director: Integrated Environmental Authorisations: Protected Areas
Date: 09/11/2015

Cc:

Jacobus Christiaan Daniel Theron	RVM 1 Hydro Electric Power (Pty) Ltd	Email: neil@hdro-sa.com
Ms Anga Yaphi	NCDEANC	Email: ayaphi@upprov.ncape.gov.za
Mr Fundisile Mketeni	SANParks CEO, Head Office, Groenkloof, PTA	Email: fundisile.mketeni@sanparks.org
Ms Lize McCourt	SANParks COO, Head Office, Groenkloof, PTA	Email: lize.mccourt@sanparks.org
Mr Paul Daphne	SANParks, Head Office, Groenkloof, Pretoria	Email: paul.daphne@sanparks.org
Dr H. Hendricks	SANParks, Head Office, Groenkloof Pretoria.	Email: hhendricks@sanparks.org
Mr Lucius Moolman	SANParks Regional Manager, Uppington.	Email: Lucius.moolman@sanparks.org
Mr. Frans van Rooyen	Park Warden Augrabies Falls National Park	Email: frans.vanrooyen@sanparks.org
The municipal manager	Kai! Garib Local Municipality	Email: mackayj@kaigarib.co.za
Dr Geoff Cowan	DEA: Protected Areas Planning, Legislation, Compliance & Monitoring Unit	Email: gcowan@environment.gov.za

3

Changes to the September 2015 Final EIA Report and issues addressed in the Addendum Report

Changes to Riemvasmaak Hydropower Project Final EIA Report September 2015 and issues addressed in Addendum Report	
Section	**Description of change / issue addressed in Addendum**
Foreword to the Final EIA Report	• Responses to some of the issues raised by DEA in the letter accepting the Final Scoping Report have been augmented in Chapter 6 of the Addendum Report.
Executive Summary (English version only: Afrikaans version remains unchanged)	• Reference to the flow rate of 30m^3/sec being "the accepted minimum environmental flow rate over the falls and into the downstream reaches of the river" has been changed to read "DWS's target minimum flow rate at Neusberg Weir".
Chapter 1: Introduction	• Two new sections have been added to section 1.3.1 – Public Participation – outlining activities in respect of the Final EIA Report (undertaken) and the Amended Final EIA Report (in progress) and associated documentation. • 1.6 – Specialist Team. Imani Development added to the list of specialists.
Chapter 2 – Description of the Affected Environment	
Section 2.3.3 - Birds	• The conservation status of all species was checked in the light of the latest IUCN List (2015-4): o The status of the Globally Threatened African White-backed Vulture, noted as EN (Endangered) at the time the specialist report was written, was revised to CR (Critically Endangered) to reflect the IUCN up-listing in April 2015. o The Globally Threatened VU (Vulnerable) status of the Black Harrier was noted. • The status of all other species was reviewed and found to be correct.
Section 2.4 – Socio-Economic Environment	• Additional information – Sectoral Analysis – has been added from the February 2016 Economic Impact Assessment (Imani 2016). • Additional information on employment opportunities presented by the project, and other benefits to the RVM Community and other local communities is provided in the new specialist rep[ort (Imani 2016) as well as in Chapter 4 of the Addendum report. • Chapter 3 of the Addendum report discusses the effects of low flows in the river on the numbers of tourists visiting the national park.
Section 2.6 – Land Ownership, Land management and Zoning	• Two legal opinions have been prepared (see Chapter 5 of the Addendum Report) that set out and discuss the role and responsibilities of SANParks, as the managers of the Augrabies Falls National Park, in approving the EIA Report in terms of the NEM: Protected Areas Act and its regulations, before it is submitted to DEA for a decision on granting or refusing environmental authorisation. This relates to paragraphs e) to h) of DEA's rejection letter.
Chapter 3 – Project description	
Section 3.3 – Considerations for the Diversion Weir	• Reference to the flow rate of 30m^3/sec being "the flow rate quoted by DWS as the environmental water requirements (EWR) applicable to the lower reaches of the river, where the Orange River becomes the boundary between South Africa and Namibia." Has been changed to read "the flow rate quoted by DWS as the target minimum flow rate at Neusberg Weir". • Chapter 2 of the Addendum Report sets out (in response to DEA's requirement for the rationale for 30m^3/sec as the flow

Changes to Riemvasmaak Hydropower Project Final EIA Report September 2015 and issues addressed in Addendum Report	
Section	**Description of change / issue addressed in Addendum**
	rate in the river at which diversion of water into the hydropower station will commence), a detailed description of the origins of the flow rate of 30m^3/sec, and its relationship with the managed hydrology of the Orange River, the most-recent (2010) estimates of the environmental flow requirements of the river in the vicinity of the project site, and the findings of the Aquatic specialist report. • A series of photographs in section 2.7 of the Addendum report compares the visual appearance of flows over the falls ranging from 18 to 181m^3/sec.
Chapter 4 – Need and Desirability	
Section 4.3 – Local Municipality	• Additional information on benefits to local communities (section 4.3.2) is provided in the new specialist report, Economic Impact assessment (Imani 2016) and Chapter 3 of the Addendum report. • Section 6.4 of the Addendum Report clarifies Eskom's practices in respect of commenting on power shortages in the project area.
Chapter 6 – Key Findings of the Specialist Studies	
Section 6.10 – Economic Impact Assessment	• A new section has been added, which summarises the findings of the new specialist report, Economic Impact Assessment (Imani 2016).
Chapter 7 – Impact Assessment	
7.1.10 - Economic	• A new section has been added describing the implications for the economic environment of not proceeding with the project.
7.3.4 – Construction phase impacts on birds	• A new mitigation measure has been added requiring a survey of breeding sites for certain species of birds prior to the commencement of construction, together with an injunction to avoid them if possible. • The mitigation measure has also been added to the appropriate section of the EMPr.
7.3.5 – Construction phase impacts on heritage resources	• A new mitigation measure has been added requiring known graves, or stone cairns that are believed could be graves, that will not be directly impacted by any infrastructure to be fenced around before construction activities commence to protect them from damage. • The mitigation measure has also been added to the appropriate section of the EMPr.
7.3.10 – Construction phase impacts on Economics	• A new section has been added describing the anticipated construction phase impacts on the economic environment.
7.4.10 – Operational phase impacts on Economics	• A new section has been added describing the anticipated operational phase impacts on the economic environment.

FOREWORD TO THE FINAL EIA REPORT

Requirements in DEA's letter of acceptance of the Scoping Report

The requirements in the department's letter dated 30th October 2013, addressed to the previous EAP for the project, Aurecon, are set out as they appeared in the letter, followed by an indication of the extent to which these requirements have been addressed in this report.

Need and desirability:
Confirmation of electricity shortage in the Northern Cape must be obtained from ESKOM in order for the Department to be able to determine the need and desirability of the activity, including the demand for the activity and the desirability of the project in line with the current land use regime of the area. This must be included in the EIR.

The applicant referred this instruction to Eskom, and received the following reply:

From: Lebohang Motoai <MotoaiLS@eskom.co.za>
Subject: RE: Proposed RVM1 Hydro Electric
Date: 7 April 2015 14:24:07 GMT+2
To: Mercia Grimbeek <mercia@hydro-sa.com>
Dear Mercia,
We do not write such letters to all IPP`S, We do not even have a template for such letters.
I am sorry cannot assist you with such letter.
REGARDS
Lebohang Motoai

It is, however, common knowledge that South Africa is experiencing an energy crisis, and that the government is seeking to procure power from all possible sources.

RVM 1 Hydro has submitted an application to Eskom for a grid connection.

Activity Position
Please provide the co-ordinates for the center point of each structure and/or infrastructure, note that for linear activities such as roads, channels and pipeline, the start, middle and end point of each must usually be provided. In this case, due to the sensitive nature of the receiving environment, the department requests you to provide the exact co-ordinates of the linear activities.

The coordinates requested above will be supplied as shapefiles.

Site Plans/ facility illustrations:
You are required to provide the Department with the final site plans and/or facility illustrations, on A3 format and in colour, which must clearly indicate the following:

- Project associated infrastructures;
- Foundation footprint of the infrastructures;
- Construction period;
- Laydown footprint;
- Internal roads and access roads indicating width and length of the roads;
- Drainage lines and rivers;
- Borrow pits;
- Spoil heaps (Location, size and extent);
- Temporary storage of topsoil and subsoil during construction (Location, size and extent);
- Closest towns;
- Environmental sensitive features and buffer areas;

- Current land use and land use zoning; and
- All "no-go" areas.

- A description of project infrastructure is provided in Chapter 3.
- The total estimated areal footprint of all structures, whether they will be visible or not when construction is completed, is set out in Chapter 3.
- The construction period is anticipated to be 3 years.
- The size of laydown areas, temporary during construction, are set out in Chapter 3.
- No borrow pits will be required.
- The area proposed for the spoil site, where surplus excavated material will be deposited until a use can be found for it, is illustrated in Chapter 3.
- An estimate of the size and extent of soil storage areas is provided in Chapter 3.
- The closest towns are Augrabies (11km from the diversion weir), Marchand (20km), and Kakamas (32km)
- CBAs and the locations of threatened ecosystems are shown on Figures 2.6 and 2.7. The AFNP Buffer Zones are illustrated in Figure 2.10a.
- Land use, land management and zoning are discussed in Chapter 2 of the EIA Report, and also in Appendix G.

Locality Map

Please ensure that the Final EIR includes at least one A3 regional map of the area. The locality maps included in the final EIR must illustrate the different proposed alignments. The maps must be of an acceptable quality and as a minimum, must have the following attributes:

- Project site;
- Alternatives:
- Cardinal points;
- Co-ordinates;
- Legible legends;
- Latest land cover;
- Vegetation types of the study area.
- Borders of the Augrabies Falls National Park and other protected areas.

Appropriately sized maps are provided in the EIA Report.

Specialist studies

The Scoping Report proposed to undertake the following specialist studies during the EIA phase:

- Visual Impact Assessment Study;
- Fauna Impact Assessment;
- Botanical Assessment;
- Cultural and Heritage Impact Assessment Study;
- Aquatic and Hydrological Impact Assessment;
- Socio-Economic and Tourism Assessment;

The Department agrees with the proposal, however; with the addition of:

- Agricultural Impact Assessment;

The following specialist studies were undertaken during the EIA phase of the assessment, or in

some cases were conducted for the original Basic Assessment (for two 10MW schemes served by the same diversion weir), and are considered still to be relevant to the revised 40MW project:

- Agriculture
- Aquatic Ecology
- Botany
- Fauna
- Geotechnical
- Heritage
- Noise
- Socio-Economics and Tourism
- Visual

A summary of the key findings of the specialist reports is provided in Chapter 6, the impacts identified and assessed by the specialists are set out in Chapter 7, and Volume 2 of the suite of documents for this assessment contains all the reports in full.

Cumulative Impact Assessment:

Please describe the cumulative impacts in terms of other similar or diverse activities as a result of the proposed project and indicate how it will be managed and mitigated. It should be noted that Orange River is an international water resource bodies, and cumulative impacts must be considered both locally and internationally. The impact of the possible change in the flow regime in the Orange River on the RAMSAR site at the mouth of the Orange River must also be assessed in detail.

Cumulative impacts are discussed in section 7.6 of this report.

We are aware that the Orange River is an international river, and we have emphasised that, because the project is non-consumptive – water is diverted from the river, passed through a turbine to generate electricity, and the returned undiminished to the river a short distance downstream of the point of diversion – there will be no impacts on the flow regime of the river downstream of the tailrace outfall. There will therefore be no impacts on the Ramsar wetland at the river mouth.

This report does provide an assessment of the impacts on the reach of river in which the project will result in a reduced flow regime (see sections 6.2, 7.1.2, 7.2.2, 7.3.2, 7.4.2, 7.5.2 and 7.6.2), The report does not, however, include a detailed assessment of possible changes in the flow regime on the Ramsar site at the river mouth, because the project will not cause any impacts at any site downstream of the Augrabies gorge. Changes in the flow regime at the river mouth will be effected only by changes to the release regime from upstream impoundments and changes in patterns of abstraction from the river for off-stream uses. These issues are managed by DWS.

Public Participation process:

Meeting held on 28 August 2013 at Augrabies Falls National Park refers, please note that the minutes of this meeting are not attached and must form part of the Draft and Final EIR.

The project must be advertised locally, provincially and nationally.

Minutes of 28Aug13 meeting

This issue has been discussed with Mr Danie Smit of DEA, and he has been provided with copies of correspondence with Ms Linda Poll-Jonker, who we believe was the Case Officer before she left the department, that clearly indicates that she was responsible for the preparation and distribution of the minutes of this meeting. Mr Smit has not yet confirmed that this was the case, and he has also not provided us with a copy of the minutes. We cannot provide a copy of the minutes that the department committed itself to prepare.

Advertisements

Copies of the advertisements placed during the EIA phase, together with proof of site notices and notifications placed in public places and local retail outlets, are provided in Appendix B to the EIA Report.

In addition, the following amendments and additional information are required for the EIR:

a) Details of the future plans for the site and infrastructure after decommissioning and the possibility of upgrading the proposed infrastructure to more advanced technologies.
b) The total footprint of the proposed development should be indicated. Exact locations of the structures and associated infrastructure should be mapped at an appropriate scale.
c) A Water Use License will be required; and the proof of application for a license needs to be submitted to DEA.
d) Possible impacts and effects of the development on the vegetation ecology with regard to lowland-highland interface in the locality should be indicated.
e) Possible impacts and effects of the development on the surrounding areas and aquatic ecosystem should be indicated.
f) The EIR should include information on the following:
   - Environmental costs vs benefits of the hydropower activity; and
   - Economic viability of the facility to the surrounding area and how the local community will benefit.
g) Information on services required on the site, e.g. sewage and refuse removal.
h) A construction and operational phase EMPr to include mitigation and monitoring measures.
i) Should blasting be required, appropriate mitigation measures should be provided.
j) The EIR must also include the rehabilitation plan and water pollution contingency plan.

a) The impacts of decommissioning are addressed Chapter 7 of this report, and the EMPr (Volume 4 of this suite of reports) includes provision for the decommissioning of the facility. However, the EMPr notes that, because of the strategic importance of electricity generating facilities in South Africa it is unlikely that the project will be decommissioned in the foreseeable future. Since the working life of the power station can reasonably be expected to be 50 years or more it is premature to be considering future plans for the site in any detail.
   The electro-mechanical equipment will, of course, require regular maintenance, and when a piece of plant or equipment reaches the end of its useful life, for whatever reason, the opportunity will be taken to upgrade it to the most-recent technology at the time.
b) The footprint of the project and the location of infrastructural elements are set out in Chapter 3, as indicated earlier in this section.
c) An application for a water use licence has been submitted to the Department of Water and Sanitation. The department has issued a non-binding letter to the applicant that, among other things, confirmed that water is available for the construction (3 years) and operation (20 years) phases of the project,
d) Impacts were assessed and mitigation measures proposed for all elements of all phases of the project, and are set out in Chapter 7 of this report.
e) Environmental costs and benefits are assessed in, among others, the Socio-Economic & Tourism specialist report. The costs and benefits are not necessarily monetised.
   The applicant has satisfied himself of the economic viability of the project; if this was not the case he would not be proceeding with the development of the project. However, this information represents the applicant's intellectual property, and is part of his competitive advantage. Relevant documentation can be made available to the department on request, provided there are assurances that it will remain confidential and not be made publicly available.
f) Services required on the site during construction and operation will comprise the provision of water (potable and non-potable) and sanitation services. Because of the remoteness of the

site it is improbable that water will be available from a municipal system, and there will certainly not be mains sewerage available. On-site services will be developed and implemented in accordance with all relevant regulatory instruments.
Since there is unlikely to be a formal refuse removal service available for the site the contractor, and subsequently the operator, will make their own arrangements for the removal of waste materials from the site, for disposal at an appropriately licensed site.

g) This report mentions the possibility that blasting will be necessary during construction, and a general specification is provided for blasting in the EMPr. Detailed operating procedures will be developed at the appropriate time before construction commences.
h) Rehabilitation is addressed in this report in respect of the rehabilitation of disturbed areas as construction proceeds, and also in the EMPr in respect of closure and decommissioning.
The potential impacts of project-related water pollution incidents are assessed in this report, and mitigation measures proposed, and are also dealt with in the EMPr.

> You are further advised in terms of regulation 30 (2), of certain matters that may prejudice the success of the application. **Therefore the Department requires you to note the following:**
>
> - The proposed development falls within a National Critical Biodiversity Area, Gariep Centre of Endemism, Priority Conservation Action Areas, and National Protected Areas Expansion Strategy.

We are aware of these aspects of the project area, and they have been taken into consideration in the assessment of impacts.

> - The proposed development is not consistent with the Augrabies Falls National Park objectives of protecting the hydrological uniqueness, geology and the environment, and the National Protected Areas Expansion Strategy, 2008. Certain infrastructure of the development is located within the Augrabies Falls National Park and on the buffer zone of the park, therefore; Management Authority viz; SANParks` approval in terms of with NEMPAA, 2003, section 50 (5) of National Environmental Management: Protected Areas Act, 2003, is required and must be obtained, prior to the submission of final EIR.

- We aware of the objectives of the park, and we are also aware that some of the infrastructure will be located within the boundaries of the park. We are, however, of the opinion that the project can be developed and operated in the national interest without there being unacceptable impacts on the park.
- The above interpretation of the requirements of the NEM: PAA is in error. We are aware that permission from the managing authority – SANParks - is required before the project can be implemented, but the Act provides no hindrance to the submission of this report, and permission to do so is not required from SANParks. Mr Smit (DEA) has confirmed this in writing.

> - At this stage the Department is concerned that development will have more negative impacts on the environment as compared to its economic and social value, looking at impacts on the biodiversity of the area, impacts on the Augrabies Falls National Park and its scenic value of the water fall, impacts on water resource and its aquatic ecosystem.

We are aware of the concerns noted in the comment above, and we have considered all of them in this assessment. We believe that this assessment has addressed the above issues in an objective and unbiased manner, and we would like the department to make its decision in a similarly objective and unbiased manner, based on this report, and any other fact-based information it chooses to consider. Accordingly we encourage the department to carefully study the information presented in this report before it makes its decision.

- The alluvial vegetation where the pipeline infrastructure is proposed to be placed is listed as endangered or threatened and the overall area is highly sensitive for both biodiversity and avifaunal species.

We are aware of the status of the vegetation in the riparian zones of the secondary channel, and it has been taken account of by the botanical specialist. The potential project-related impacts on vegetation and fauna have been comprehensively assessed, and the results are reported in this document.

- It should be noted that there is already environmental concerns regarding the flow regime which has downstream impacts on the Orange River Mouth estuary, a Ramsar site, and the Agricultural irrigation schemes downstream.

We are aware of these concerns, and they are entirely misplaced in the context of this proposed project. As clearly stated previously in this section, and as acknowledged by DWS, the project is non-consumptive, and will not affect the irrigation schemes downstream of the Augrabies gorge , and it will certainly not affect the Ramsar wetland at the river mouth in any way.

- The Department suggest that other alternative sites, which do not fall inside or close to the Augrabies Falls National Park and that might not impact on the water flow of the waterfall, be considered.

Alternative sites studied by the applicant are discussed in Chapter 5 of the EIA Report, where it is pointed out that there are few sites on South African rivers that are suitable for the generation of electricity without the need to construct large impounding reservoirs to generate the necessary head, such as, for instance, the Gariep and Van der Kloof dams, both of which have had, and will continue to have, a profound influence on the flow regime of the Orange River. In this context we note that the DEA has recently granted environmental authorisation for a further large instream dam on the Orange River, to facilitate the generation of 22MW of power at the Rooikat HPP.

As we have stated previously we believe that this project can be developed and operated with minimal effects on the nature of the park and its surroundings, and with minimal effect on the Augrabies Falls, or the Orange River as a whole, as a tourist attraction.

Shapefiles

A shapefile of the preferred development layout/footprint must be submitted to this Department. The shapefile must be created using the Hartebeesthoek 94 Datum and the data should be in Decimal Degree Format using the WGS 84 Spheroid. The shape file must include at a minimum the following extensions i.e. .shp; .shx; .dbf; .prj; and, .xml (Metadata file). If specific symbology was assigned to the file, then the .avl and/or the .lyr file must also be included. Data must be mapped at a scale of 1:10 000 (please specify if an alternative scale was used). The metadata must include a description of the base data used for digitizing. The shapefile must be submitted in a zip file using the EIA application reference number as the title.

Shapefiles will be provided on the CDs containing the electronic copies of the EIA Report and supporting documentation.

Changes to the April 2015 Draft EIA Report

A number of changes have been made to the April 2015 Draft Environmental Impact Assessment report, as a result of comments from I&APs and information received since the publication of the

Draft report. These changes are tabulated below. Minor amendments such as corrections of typographic errors, and changes to reformatting and repagination are not noted in the table.

Changes to Riemvasmaak Hydropower Project Draft EIA Report April 2015	
Section	**Description of change**
Section 1.3.2 – EIA Regulations and Listed Activities, page 3 Section 1.4 – NEMA EIA Regulations 2014	Section and Table 1.2 added – comparison between Listed Activities in 2010 and 2014 NEMA EIA Regulations
Section 2.2.4 – Critical Biodiversity Areas	Explanation added of the mention of the Namakwa District Municipality (the project is in the ZF Mgcawu District) in relation to Biodiversity Sector Plans, Environmental Management Frameworks, Critical Biodiversity Areas and Ecological Support Areas.
Section 2.4.2 – Overview of the project area,	Text revised to confirm that part of the project site is within the boundaries of the Augrabies Falls National Park.
2.6 – Land Ownership, Land management and Zoning Executive Summary & Uitvoerende Opsomming	The section has been reorganised and augmented to include a summary of a Legal Opinion relating to two farm portions and the channel and riparian zone of the Orange River. A new map (Figure 2.9a) has been included showing the AFNP Buffer Zones A clearer indication of properties affected by the overhead power line has been added. The changes are reflected in summary form in the Executive Summary / Uitvoerende Opsomming
Section 3.3.2 – Environmental water requirements	A new section has been added in response to enquiries raised by I&APs, in which the results of previous EWR assessments by others are analysed and compared with the recommended minimum environmental flow of 30 m^3/sec.
Section 3.3.4 – Downstream effects	A brief statement has been added to explain the downstream effects of the diversion, in response to concerns raised by *inter alia* DEA
Section 4.2.6 – The REIPPPP	A brief paragraph has been added explaining the benefits to the national grid and local supply system of the input of 40MW of power.
Section 4.3 2 – Benefits to local communities	A more complete description of the project funding arrangements has been added.
Section 5.2.1 – Design / layout Alternatives	Figure 5.1 has been added to facilitate a better understanding of the alternatives for the location of the power house and the routes of the headrace.
Section 7.6.2 – Cumulative impacts	A note has been added confirming that DEA has granted Environmental Authorisation for the Rooikat HPP, upstream if the Augrabies falls, which involves the construction of a 30m-high instream dam and the inundation of 550 ha of land to produce 22MW of power.
Section 8.2 – EAP's Recommendation	A new section has been added setting out the Conditions that should be attached to the Environmental Authorisation for the project.

EXECUTIVE SUMMARY

SITE LOCATION AND INFRASTRUCTURE

RVM 1 Hydro Electric Power (Pty) Ltd (RVM) intends to construct a run-of-river hydroelectric power station on the Orange River on the farm Waterval (Remainder of Farm no. 497) and Portion 1 of Farm no. 498 (known as Riemvasmaak), north of the Augrabies Falls, approximately 32km north west of Kakamas in the Northern Cape Province of South Africa.

The power station will have an installed generating capacity of 40 megawatts (MW), and the annual energy output from the facility is anticipated to be approximately 235 gigawatt-hours (GWh). Long-term hydrological records indicate that sufficient water will be available in the Orange River to generate base load electricity for 80% of the time.

In broad terms the project will entail the construction of infrastructure comprising:

- A low diversion weir across the Orange River approximately 1.5 km upstream of the Augrabies Falls.
- An off-take structure at the weir to facilitate diversion of water from the river.
- A conduit – the headrace - to convey water from the intake structure to the penstock head pond.
- A head pond and power station intake structure - forebay.
- Vertical (or very steep) penstocks – pipes - to transfer the water from the head pond to the power chamber, and to provide access & fresh air to the power chamber
- An underground power chamber containing up to four Francis turbines.
- An underground tailrace and outlet works to convey water from the power chamber back to the river channel.
- Haul roads to facilitate access for construction and the removal of excavated material off site for disposal or re-use.
- A high voltage (HV) power line to evacuate the power from the power station to the national grid.
    - Underground cable across portions 1/497 and Rem 498 (approximately 7.5 km).
    - Overhead power line across the river, over private land to the connection point (approximately 8 km).
- A transformer yard and mini substation located at the head pond and a new substation.
- Fencing as required for public safety.

LAND OWNERSHIP AND RIGHTS

Working from the tailrace outfall upstream to the diversion weir, the main elements of infrastructure will be located on three portions of land, as described in the following sections.

Portion 1 of farm Riemvasmaak No 498:

- The downstream ±1km of the headrace.
- The headpond, overflow spillway and penstock forebay.
- The penstocks.
- The powerhouse and electrical infrastructure.
- The tailrace and tailrace outfall into the Orange River.
- About 2km of the underground transmission line.
- About 2km of the access road.
- An access road or haulage way to the tailrace outfall point.

- This portion of land is owned by the Riemvasmaak Gemeenskapontwikkelingstrust (Community Development Trust), in terms of Deed of Transfer T818/1996.
- The land (known at the time as Melkbosrand) was excluded from the Augrabies Falls National Park on 28th May of 2004 via Government Notice 657 in Government Gazette 26374, but is

currently managed by SANParks in terms of a draft agreement made between SANParks and the Trust in May 1996. It is noted in section 2.3 of the Augrabies Falls National Park Management Plan that "*negotiations on the management of Melkbosrand between the community and SANParks are ongoing*", and in section 2.5 the Plan notes that "*A committee, the Melkbosrandsamewerkingskomitee (MSK), has been established to achieve consensus on the management of the area north of the Orange River*."

- No public access to the land is permitted.

Construction of the project-related infrastructure will require the Applicant and the Trust to enter into a long term Lease Agreement, which was signed in July 2015 after approval by a special general meeting of the Trustees and beneficiaries of the Trust.

The land is currently zoned Agriculture Zone 1. Given the extent of the infrastructure it will be necessary to apply for a temporary departure from the current zoning for the whole period of construction of underground works, reverting to the current zoning once construction is completed and the land surface is rehabilitated. Above-ground works will require an application for rezoning to Special Zone.

Remainder of farm Waterval No 497:

- The first approximately 3.6km or so of the headrace.
- Approximately 6km of underground power line.
- Approximately 6km of access road.

- The land is owned by the Republic of South Africa in terms of Deed of Transfer T5921/1912 dated 20th February 1912 (Appendix G).
- The land is included on the Assets Register of the Department of Public Works, which is the custodian of all national property, and is reserved for the National Parks Board.
- This portion of land is included within the boundaries of the Park in terms of the definition of the area of the park in Schedule 1 of the National Parks Act, 57 of 1976.
- No public access to the land is permitted.

Construction of the project-related infrastructure across this land will require the establishment of servitude or servitudes, for which application has been made to the Department of Public Works.

The land is currently zoned Open Space Zone III –Conservation Area. Given the extent of the infrastructure it will be necessary to apply for a temporary departure from the current zoning for the whole period of construction of underground works, reverting to the current zoning once construction is completed and the land surface is rehabilitated. Above-ground works will require an application for rezoning to Special Zone.

The Orange River and its right-bank riparian zone:

- Diversion weir,
- Offtake structure,
- First few metres of the headrace.
- A few metres of buried cabling.

- This area of land does not have a property reference number.
- According to the definition of the area of the Park in the National Parks Act, 1976, the river channel and its riparian zones are included in the boundaries of the park.

Similar to Remainder of farm Waterval 497 discussed above, the land is owned by the State, under the custodianship of the Department of Public Works, and an application for the establishment of servitude or servitudes has been made to the Department of Public Works.

In addition, an application for a water use licence has been prepared for the construction of the diversion weir and Offtake works, in accordance with the requirements of the National Water Act,

326 of 1998. The application has been submitted to the Department of Water and Sanitation with a copy this Environmental Impact Assessment Report.

The zoning of this land is Open Space Zone III –Conservation Area, because it is included in the national park. All infrastructure on this land is above ground, and it will be necessary to apply for rezoning to Special Zone.

Overhead Transmission Lines

The route of the overhead transmission lines from the boundary of Remainder of farm 497 Waterval to the connection into the national grid is shown on Figure 3.2. The route crosses a number of parcels of land, which are all privately owned with the exception of the Orange River crossings, and which are listed in Table 2.18 of the report, together with the names of the registered owners of the land.

Flow over the Augrabies Falls

The Augrabies Falls is an important tourist attraction in the area and it is important to understand that activities associated with the RVM1 Hydro Power Plant will not cause the falls to "dry up". A minimum of 30m^3/s – the Department of Water and Sanitation (DWS's) target minimum flow rate at Neusberg Weir - will always flow past the weir and on to the Augrabies Falls, when that amount of water is in the river. (The hydrological record indicates that there have been occasions in the recent past when releases from the upstream dams and abstractions from the river have reduced the flow rate in the river to below 30m^3/s.) As the flow rate in the river increases above 30m^3/s the additional flow will be shared between the power plant and the main river flow over the falls, until the rate of diversion of water from the weir to the power station reaches its maximum of 38m^3/s. At this point the diversion of water into the power plant is restricted to 38m^3/s by control gates in the offtake structure,

An important consideration in the design of the weir is that it will not result in increases in upstream water levels that adversely affect irrigation or drainage infrastructure on the mid-stream or floodplain farms and vineyards upstream of the weir. The construction of the weir will raise upstream water levels, but mathematical modelling – backwater calculations in a numerical simulation of the multiple river channels – indicates that increased water levels extend for a distance of about 3km upstream of the weir. This is known as the limit of influence of the weir, it is downstream of any cultivated areas adjacent to or between the active river channels, and indicates that the weir will not adversely affect irrigation or drainage infrastructure in these areas.

ENVIRONMENTAL IMPACTS

Impacts on agriculture, the botanical environment and the faunal environment

Shallow soils and aridity constraints mean that the site is not currently used for agriculture, and is unlikely to be used for agriculture in the future. Most project infrastructure is planned upon land type Ag2. Soils across this land type are shallow, red, sandy soils on underlying rock and are classified as Hutton, Mispah and Glenrosa soil forms according to the South African soil classification system. Most of the site has a land capability classification, on the 8 category scale, of: Class 7 - non-arable, low potential grazing land. The rocky gorge areas are classified as Class 8 - non-utilisable wilderness. Minimal impacts on agriculture are expected.

The Riemvasmaak study area is not botanically sensitive in a broad sense and apart from Lower Gariep Alluvial Vegetation, the flora and vegetation are not threatened. However, the environment is well conserved and is distinctly "wilderness". The ecosystem is largely intact and undisturbed. Rehabilitation and four years of monitoring are recommended as mitigation measures to reduce impacts on the botanical environment.

The project area is one of the 122 Important Bird Areas in South Africa. It retains significant components of Nama Karoo faunal biodiversity, and due to its proximity to the AFNP forms an important component of protection of this biome. Few amphibians occur in the Lower Orange River area, with a maximum of 12 species likely to occur in the project area. No amphibians are endemic

to the region and no amphibians of conservation concern occur. The most sensitive habitats for amphibians are perennial pools of water in the Orange River palaeochannels. Reptile diversity in the region is much greater, with 57 species known to occur in the region. Two lizards are Near Endemic to the region, but no reptiles of conservation concern are present. The most sensitive habitats for reptiles are expansive rocky areas, particularly in the 'Canyon Zone'. The majority of mammals present in the project area are small to medium-sized. Mammals use all habitats in the region, and the rock fissures and cracks of the Canyon region form roosts for large numbers of bats which play an important role in the control of insect pests over the irrigated agricultural lands, as well as the control of black fly pests that have a significant economic impact in the region.

Impacts on aquatic ecology

The river reach has suffered a change from its reference (pre-development) condition in terms of biological integrity (fish, macro-invertebrates and riparian vegetation) as well as in-stream and riparian habitat, mostly as a result of transformed hydraulic conditions brought about by release management of upstream impoundments, and water quality impacts mostly from irrigated agriculture and some minor mining in the region. Even though there are transforming and degrading features present in the river reach, the overall Ecological Importance and Sensitivity (EIS) remains high. The surface water quality throughout the survey area is considered good, with the aquatic system supporting a diversity of sensitive aquatic macro-invertebrate taxa. It is therefore imperative that project-related activities that could cause contamination of the surface waters through deleterious effluents and runoff water be strictly managed and controlled. Regular monitoring of water quality to enable early identification of contamination is recommended. Although a natural migratory barrier exists in close proximity to the proposed weir site in the form of the Augrabies Falls, this section of the river is considered relatively productive and therefore it is recommended that consideration be given to including provision for fish passage in the weir.

Impacts on the socio-economic environment

The project is anticipated to provide between 150 to 200 temporary opportunities during the construction phase, whilst between five and ten permanent opportunities will be created during the project's operational phase. Most of the opportunities will be afforded to the surrounding communities, which should increase the general wages of some households during the construction phase. This should impact positively on the local economy, as the disposable income will be increased. The RCT will benefit due to dividend and rental income associated with the project. In addition, the REIPPPP requires that community trusts in the broader areas be identified and supported by renewable energy projects.

The Augrabies Falls is a significant tourist draw card in the region. The main attraction within the reserve is the Augrabies Falls itself, a 56 m high waterfall with various viewing decks and the park reception in near vicinity. Changes to the sense of place which may impact negatively on tourism in the area are impacts on the aesthetic nature of the area and an increase in noise and dust associated with construction activities. The natural beauty of the area; virtually no 'unnatural' noise and the general 'peace and tranquillity' associated with the AFNP are significant attractions for tourists visiting the park as well as for people rafting, paddling or fishing on/in the river.

While a minimum of 30m³/s will always be channelled to the falls, provided the flow of the river is not below this level, there will always be a slight reduction in the amount of water reaching the falls when the river is flowing above 30m³/s. The issue of reduced flow and the impact it may have on tourism for the park and tourists' experience of the falls was identified by representatives of the AFNP who noted the importance of the falls in attracting tourists. In an effort to gauge the importance of the volume of water moving over the falls on the number of visitors to the park, visitor data from March 2009 to August 2013 were compared with flow data for the same period. Data from February 2010 and January 2011 show that during times of high flow, the number of visitors to the park increases significantly, suggesting a direct correlation between the level of flow and the number of visitors to AFNP. However, it needs to be noted that at these particular times the Orange River was in flood. From September 2011 to August 2013, while the flow has remained relatively consistent, there have still been noticeable spikes in visitors to the Park around the August and September periods, probably occasioned by seasonal tourists en route to

Namaqualand, and December and January, a peak holiday period. The increase in tourists during these times can also be seen in 2009 and 2010. These findings suggest that while there is likely to be a large influx of tourists during times of flood, generally, the number of visitors to the Park is not solely determined by the volume of water over the falls.

Impacts resulting from Seismicity

Work by the Council for Geoscience has identified and defined the occurrence of a recent earthquake swarm in the Augrabies area, which commenced in July 2010 and consisted of continual small seismic tremors. No events of magnitude equal to or greater than 3.0 have occurred since 2012, and not a single event exceeding a magnitude of 5.0 (approximately equivalent to Modified Mercalli intensity scale VI) has occurred during the currency of the swarm. Nevertheless, all structures will have to be designed to resist tremors at least equal to the maximum magnitude recorded during the swarm thus far. It is considered highly unlikely that cavities could form, as the local geology is not conducive to the formation of cavities or sinkholes (it is not dolomitic terrain).

Impacts on heritage, noise and visual

Graves have been identified and avoided in the routing of infrastructure. Other sensitive heritage features have been identified, but the project infrastructure will result in no impacts on these.

Daytime noise levels associated with construction activities are expected to be limited to an area within 500 meters from the activity. The assessment could not identify receptors living within 2,000 meters from the proposed development, excluding the power line. The criteria as set out in the SANS10328:2008 guidelines indicate a low potential for a noise impact during operations, due to the fact that infrastructure will mostly be buried.

Little can be done to mitigate visual impacts during construction, but during operation visual impacts will be less significant, since most infrastructure will be buried, and many will become increasingly less significant as rehabilitation works take effect. However, certain infrastructure components will be visible throughout the project's existence, namely: the diversion weir and offtake structure (which are located in and immediately adjacent to the river channel), and the substation and the 132 kV overhead line (which are located off the project site on the adjacent privately owned properties). Landscaping of the spoil dump will assist in reducing the visual impact of the deposited material, and continuous rehabilitation will be carried out to ensure that the site does not deteriorate. It is possible that, over time, some material will be moved off site and used for construction purposes. With the exception of the riparian vegetation next to the weir, which may go some way to concealing the offtake structure, the vegetation of the area is sparse, and will not contribute significantly to blocking views of the project infrastructure.

The impacts identified for the various phases of the project are as follows:

Impact Study	Impact Description	Without mitigation	With mitigation
NO-GO / EXISTING LAND USE IMPACTS			
Aquatic ecology	Degradation of ecological condition of river	**High -**	**N/A**
Botanical	Preservation of existing vegetation	**High +**	**N/A**
Fauna	Faunal conservation	**High +**	**N/A**
Visual	The positive visual impact of retaining the area within the AFNP and surrounds undeveloped, in a natural state and with no visual intrusions.	**High +**	**N/A**
CONSTRUCTION PHASE IMPACTS			
Agriculture	Reduction of agricultural potential	**Low -**	**Low -**
Aquatic ecology	Destruction of aquatic habitat to accommodate weir construction	**Low -**	**Low -**
	Destruction of local watercourses and side tributaries to accommodate the construction of the headrace	**Low -**	**Low -**
	Reduction of water volume flowing over the Augrabies Falls to accommodate the hydropower scheme	**Low -**	**Low -**
	Contamination of surface water features leading to loss of sensitive biota	**Mod -**	**Low -**
	Impacts on riparian vegetation leading to decrease in filtration of runoff	**Mod -**	**Low -**
	Biodiversity impacts due to riparian vegetation loss	**Mod -**	**Low -**
	Decreased flood attenuation capacity from removal of riparian vegetation	**Mod -**	**Low -**
	Increased rate of erosion from soil stripping, soil compaction and vegetation removal	**Mod -**	**Low -**
	Erosion and habitat destruction from stockpiled topsoil and disturbance of soils	**Mod -**	**Low -**
Botanical	Impact due to construction of the intake facility	**High -**	**Mod -**
	Impact due to construction of the preferred option conduit route	**High -**	**Mod -**
	The powerhouse location with headpond and tailrace	**High -**	**Mod -**
	Transmission line routes (Bushmanland Arid Grassland and Lower Gariep Broken Veld - cable same channel as head race)	**Low -**	**Low -**
	Transmission line routes (Bushmanland Arid Grassland - cable alongside access road)	**Mod -**	**Low -**
Fauna	Loss of Amphibian Diversity	**Low -**	**Low -**
	Loss of Reptile Diversity	**Mod -**	**Low -**
	Loss of Bird Diversity	**Mod -**	**Low -**
	Loss of Mammal Diversity	**Mod -**	**Low -**
	Loss of Species of Conservation Concern	**Mod -**	**Low -**
	Impacts on fauna due to habitat fragmentation and habitat loss	**Very high -**	**Mod -**
	Ecological impacts from dust	**Low -**	**Low -**
	Disruption to fauna from increased noise levels	**Mod -**	**Mod -**
	Chemical Pollution	**Mod -**	**Low -**
Heritage	Potential impacts on graves	**High -**	**Mod -**
	Potential impact on the cultural landscape	**Mod -**	**Low -**
	Potential impact on the heritage of the AFNP	**Mod -**	**Low -**
Noise	General noise impacts	**Mod -**	**Low -**

Impact Study	Impact Description	Without mitigation	With mitigation
Socio-economic and tourism	Land Loss	Low -	Low -
	Temporary Disruption to Farming Activities	Low -	Low -
	Employment Opportunities	Mod +	High +
	Stimulating Small, Medium and Micro Enterprises	Low +	Mod +
	Increase in Informal Traders	Low +	Low +
	Tourism	Mod -	Low -
	Spread of Diseases	Low -	Low -
	Increased Road Accidents	Mod -	Low -
	Increase in Dust	Low -	Low -
	Fire hazard	Mod -	Low -
	Increased Criminal Activities	Low -	Low -
	Increased pressure on existing social infrastructure	Mod -	Low -
Visual	The potential negative visual impact of the project component on sensitive visual receptors in close proximity to the infrastructure or activities.	Mod -	Mod -
Seismicity	Impact of seismicity on construction	Low -	Low -
Economic	Increased dust nuisance	Low -	Low -
	Impacts on public roads	Mod -	Low -
	Increased tourism bed-nights	Mod +	N / A
	Increased Retail/SME Turnover	Mod +	Mod +
	Increased employment	Mod +	Mod +
OPERATION PHASE IMPACTS			
Aquatic Ecology	Transformation of aquatic habitat upstream of the weir	Low -	Low -
	Barrier to instream migration	Low -	Low -
	Creation of artificial habitat in episodic watercourses	Low -	Low -
	Contamination of surface water features	Low -	Low -
	Erosion of the watercourse at outfall sites (tailrace)	Low -	Low -
	Contamination of surface waters	Low -	Low -
	Exotic vegetation encroachment	Low -	Low -
	Habitat transformation and sedimentation of aquatic habitats	Mod -	Low -
Botanical	Impacts on the aesthetics of the project area as a conservation area	Mod -	Low -
Fauna	Loss of faunal biodiversity	Low -	Low +
	Loss of Species of Conservation Concern (SCC)	High -	Mod -
	Introduction of Alien fauna	Low -	Low -
	Threats to Animal Movements	High -	Mod -
	Impacts on fauna due to habitat fragmentation and habitat loss	Low -	Low -
	Impacts due to changes in hydrology	Mod +	N/A
	Increased Dust Levels	Low -	Low -
	Noise Pollution	Low -	Low -

Impact Study	Impact Description	Without mitigation	With mitigation
Socio-economic and Tourism	Financial Benefits to the Riemvasmaak Community Trust	**High +**	**High +**
	Establishing a Broad-Based Community Trust	**High +**	**High +**
	Stimulating Small, Medium and Micro Enterprises	**Mod +**	**Mod +**
	Increase in informal traders	**Low +**	**Low +**
	Employment Opportunities	**Mod +**	**High +**
	Increased Road Accidents	**Low -**	**Low -**
	Improved Energy Production	**Mod +**	**Mod +**
Visual	The potential negative visual impact of the project component on sensitive visual receptors in close proximity to the under-ground infrastructure.	**Mod -**	**Low -**
Seismicity	General impacts of seismicity on the operations phase	**Mod -**	**Low -**
Economic	Increased tourism bed-nights	**Low +**	**N / A**
	Increased employment	**Low +**	**Mod +**
	Benefits for RCT and Broad-based Community Trust, and Socio-economic Expenditure	**Mod +**	**N / A**
	Impacts on energy	**Mod +**	**N / A**
DECOMMISSIONING PHASE IMPACTS			
Fauna	Increased Dust Levels	Low -	Low -
	Noise Pollution	Mod -	Low -
Socio-economic and Tourism	Increased Employment Opportunities	Mod +	High +
	Stimulating Small, Medium and Micro Enterprises (SMMEs)	Low +	Mod +
Visual	The potential residual visual impact of the project component after the decommissioning of the power station.	Mod -	Low -
CUMULATIVE IMPACTS			
Impact Study	**Impact Description**	**Without Mitigation**	**With Mitigation**
Fauna	Surrounding land use impacts on fauna	**High -**	**N/A**
	Habitat Loss	**High -**	**N/A**
Heritage	Potential impacts on archaeological heritage resources	**Mod -**	**N/A**
	Potential impacts on graves	**High -**	**N/A**
	Potential impact on the cultural landscape	**Mod -**	**N/A**
Socio-economic and Tourism	An Increase in Expendable Income	**High +**	**High +**
	Improved Access to Social Services	**High +**	**High +**
	Increased Road Accidents	**High -**	**High -**
	Increase in Dust	**Mod -**	**Low -**
Visual	The potential contribution of the project infrastructure to the increase of similar developments within the region.	**Mod -**	**Low -**

Conclusions

It is anticipated that many of the botanical and faunal impacts will be reduced with final engineering design being cognisant of the findings and sensitivities identified in this report, the effective management of the site during construction, as well as the utilisation of appropriate rehabilitation techniques after construction. Since most infrastructure will be underground, the land surface will be properly rehabilitated, and with time the evidence of the underground infrastructure will become increasingly difficult to detect, as is evidenced by the Drakensberg Pumped-Storage Hydroelectric power project.

There will be above-ground infrastructure evident after construction is completed. The weir will be a low structure and cannot be regarded as offensive, since for most of the time the spillway sections will be overflowing with water, and only the flanking walls will be visible. The offtake works will be substantial, but with as sympathetic careful architectural treatment as can be applied to a structure of this nature, and regrowth of the riparian vegetation disturbed by construction, the structure will become less and less obvious. There will be above-ground structures at the head pond, including a power chamber access structure and a switchyard / substation. There is potential in this very remote area to position these so as to limit visibility from all but the highest vantage points in the area, and it is improbable that they will be visible from the National Park.

A minimum flow requirement of 30 cubic metres per second down the Augrabies Falls will never be prejudiced by diversion of water to the hydropower project, and the diversion of water into the project will be effected progressively as the flow rate in the river increases. It is improbable that this will significantly diminish the visual spectacle of the falls, since it is difficult for the normal visitor to distinguish between flows between 30 and around 70 cumecs.

We are not insensitive to the concerns expressed thus far by SANParks and the management of the Augrabies Falls National Park. We acknowledge that the construction of the project will need to be carried out with the utmost care and, if the mitigation measures proposed in this report are consistently and diligently implemented, we believe that this phase of the project can be undertaken with minimal inconvenience to the Park and its visitors. This is especially so since access to the northern parts of the Park has been limited to SANParks staff for a number of years and the ordinary visitor will not be significantly inconvenienced by the project.

As discussed previously, when construction is completed and the site is rehabilitated, we are of the opinion that its influence on the Park will be negligible. Its influence on the local population and the country as a whole will, however, be significantly positive, and accordingly we encourage SANParks to regard this project as being in the national interest, and not as a threat to the integrity of the Park.

Accordingly, under the conditions described in this report and the associated Draft Environmental Management Programme, we recommend that the project receive Environmental Authorisation in sufficient time for it to be considered in Round 5 of the Department of Energy's renewable energy bidding process.

UITVOERENDE OPSOMMING

LIGGING EN INFRASTRUKTUUR

RVM 1 Hydro Electric Power (Pty) Ltd (RVM) beoog om 'n loop-van- rivier hidro-elektriese kragstasie op die Oranjerivier, op die plaas Waterval (Restand van plaas nr. 497) en gedeelte 1 van plaas nr 498 (bekend as Riemvasmaak), noord van die Augrabies waterval, ongeveer 32km noord-wes van Kakamas in die Noord-Kaap Provinsie Suid-Afrika, te bou.

Die kragstasie sal 'n geïnstalleerde opwekkingskapasiteit van tot 40 megawatt (MW) hê, en die jaarlikse energie produksie van die fasiliteit sal na verwagting ongeveer 235 gigawatt-uur (GWh) wees. Langtermyn-hidrologiese rekords dui daarop dat voldoende water in die Oranjerivier beskikbaar sal wees om basislading elektrisiteit vir 80% van die tyd op te wek.

In breë terme sal die projek die bou van die volgende infrastruktuur behels:

- 'n Lae-afleding keerwal oor die Oranjerivier ongeveer 1.5km stroomop van die Augrabies waterfalle, asook 'n afneemstruktuur by die keerwal om water aflei te fasiliteer.
- 'n Ondergrondse watervoor – wat die water vanaf die inname struktuur tot by die hoofdam sal lei.
- 'n Hoof dam met kragstasie inname struktuur ('forebay').
- Vertikale (of baie steil) skag wat water vanaf die hoofdam na die kragkamer toe lei, en 'n lug toevoer sowel as onderhouds ingang na die kragkamer sal verskaf.
- 'n Ondergrondse krag kamer met tot vier Francis turbienes.
- 'n Ondergrondse afneempyp en uitlaat sisteem wat water vanaf die krag kamer na die rivier terugvoer.
- Vervoerpaaie wat toegang tot die konstruksie area bied, en verwydering van grondmateriaal en ander boumateriaal fasiliteer.
- 'n Hoë spanning (HV) kraglyn om die krag vanaf die kragstasie na die nasionale netwerk toe voer.
    - 'n Ondergrondse kragkabel onder die gedeeltes 1/497 and Restant 498 (ongeveer 7.5 km) en;
    - Oorhoofse kraglyne oor die rivier, asook oor die private grondgebiede tot by die koppelingspunt (ongeveer 8km).
- 'n Transformator agterplaas en mini-substasie geleë langs die hoof dam en 'n nuwe substasie.
- Veiligheidskerm vir publieke veiligheid.

GRONDBESIT EN REGTE

Vanaf die 'tailrace' uitlaat, tot net stroomop van die afleidingskeerwal, sal die hoof infrastruktuurelemente oor drie grond gedeeltes geleë wees. 'n Gedetailleerde beskrywing volg hieronder:

Gedeelte 1 van Plaas Riemvasmaak No 498:

- Die ± 1km stroomaf boonste water afleiding.
- Die hoofdam, oorloop en valdeur reservoir.
- Die valdeure.
- Die krag kamer en elektriese infrastruktuur.
- Die uitvoerwater en uitvoerwater-uitloop in die Oranjerivier.
- Die 2km van die ondergrondse kraglyn.
- Die 2km van die toegangspad.
- 'n Toegangspad of vervoerpad na die 'tailrace' uitloop punt.

- Hierdie grondgedeelte word deur die Riemvasmaak Gemeenskapontwikkelingstrust, in terme van Akte T818/1996 besit.
- Die grond (histories bekend as Melkbosrand) was op die 28ste Mei 2004 (in terme van Goewermentskennisgewing 657 in Staatskoerant 26374) uit die Augrabies-Waterval Nationale

Park gebied, uitgesluit, maar word vanaf Mei 1996 deur die Parkeraad in terme van 'n konsep-ooreenkoms tussen die Parkeraad en die trust bestuur . Dit is bekend gemaak in afdeling 2.3 van die Augrabieswaterval Nasionale Park Bestuurs Plan dat "onderhandelinge oor die bestuur van Melkbosrand tussen die gemeenskap en die Parkeraad nogsteeds voortduur" en artikel 2.5 van die plan wys daarop dat "'n komittee, die Melkbosrandsamewerkingskomitee (MSK), gestig is om konsensus oor die bestuur van die gebied noord van die Oranjerivier te bereik."

- Geen publieke toegang tot die gebied word toegelaat nie.

Konstruksie van die projek-verwante infrastruktuur sal vereis dat die aansoeker en die Trust 'n lang termyn huurooreenkoms betree, wat in Julie 2015 gesluit is. So 'n reëling is opgestel en geodgekeurdeur 'n spesiale algemene vergadering van die trustees en begunstigdes van die trust.

Die grond word tans as Landbou Sone 1 gesoneer. Gegewe die omvang van die infrastruktuur sal dit nodig wees om aansoek te doen vir 'n tydelike afwyking van die huidige sonering vir die konstruksie tydperk (vir die ondergrondse strukture), waarna dit terug sal keer na die huidige sonering met voltooing van die konstruksie periode en grondoppervlak gerehabiliteer is. Bogrondse konstruksiewerk sal 'n aansoek om hersonering na Spesiale Sone vereis.

Restant van die plaas Waterval nommer 497:

- Die eerste 3.6km of so van die ondergrondse watervoor
- Ongeveer 6km van die ondergrondse kraglyn.
- Ongeveer 6km van toegangspaaie.

- Die grond word tans deur die Rebubliek van Suid-Afrika besit, in terme van Akte T5921/1912 gedateer 20th February 1912 (Bylae G)
- Die grond is ingesluit in die bateregister van die Departement van Openbare Werke, wat die toesighouer van alle nationale bates is, en (volgends DOW) is die land gereserveer vir die Nasional Parke Raad. Die gedeelte van grond val binne die grense van die Park, volgense die definisie van die park area in Skedule 1 van die Nationale Parke Wet, 57 van 1976.
- Geen publieke toegang tot die grond word toegelaat nie.

Konstruksie van die projek-verwante infrastruktuur op die eindom sal die vestiging van 'n serwituut of serwitute vereis. Aansoek hiervoor was ingedien by Department Openbare Werke.

Die grond is tans as Oopruimtesone III Instandhouding Area gesoneer. Gegewe die omvang van die infrastruktuur sal dit nodig wees om aansoek te doen vir 'n tydelike afwyking van die huidige sonering vir die konstruksie tydperk van die ondergrondse konstruksie werk. Daarna sal dit terugkeer na die huidige sonering, en die grond oppervlak sal gerehabiliteer word. Bogrondse werke sal 'n aansoek om hersonering na Spesiale Sone (- Aanhangsel G pers komm Macroplan April 2015) vereis.

Die Oranje Rivier en die regterbank rivieroewer sone:

- Afleiding keerwal
- Afneem struktuur
- Die eerste paar meter van die ‘headrace’.
- ‘n Paar meter van die ondergrondse kragkabels.

- Hierdie gedeelte grond het nie ‘n eiendom verwysings nommer nie.
- Volgens die definisie van die park area in die Nasionale Parke Wet, 1976, is die rivier kanaal en die rivieroewer sones in die Park area ingesluit.

Soortgelyk aan Restant van die plaas Waterval 497 soos bo bespreek, word die grond besit deur die staat en val onder die kuratorskap van die Departement van Openbare Werke. 'n Aansoek vir die vestiging van 'n serwituut of serwitute is by die Departement van Openbare Werke ingedien.

Daarbenewens sal 'n aansoek om 'n waterverbruikers lisensie vir die opstel van die konstruksie

van die afleiding keerwal-en afname werke, in ooreenstemming met die vereistes van die Nasionale Waterwet, 326 van 1998 ingedien word. Die aansoek sal aan die Departement van Water en Sanitasie voorgelê word terselfde tyd as hierdie Omgewingsinvloedbepalingsverslag.

Die sonering van hierdie grond is nie tans bekend nie, maar dit word aanvaar dat dit gesoneer is as Oopruimtesone III Instandhouding Area, aangesien dit in die nasionale park ingesluit is. Alle infrastruktuur op hierdie grond is bo-gronds, en dit sal nodig wees om aansoek te doen vir hersonering na Spesiale Sone (pers komm Macroplan April 2015 - Aanhangsel G).

Oorhoofse transmissie lyn

Die roete van die oorhoofse transmissielyne vanaf die grens van, Restant van die plaas 497 Waterval, tot aan die koppeling met die nasionale netwerk, word op Figuur 3.2 aangedui. Die roete strek oor 'n aantal eiendomme, wat almal in private besit is, met die uitsondering van die Oranjerivier kruising, wat gelys is in Tabel 2.18 van die verslag, tesame met die name van die geregistreerde eienaars van die verskeie eiendomme.

Water vloei oor die Augrabies Watervalle

Die Augrabies-waterval is 'n belangrike toeriste-aantreklikheid in die gebied en dit is belangrik om te verstaan dat die aktiwiteite wat verband hou met die RVM1 Hydro Krag Stasie, nie sal veroorsaak dat die waterval "opdroog" nie. 'n Minimum van $30m^3/s$ - die aanvaarde omgewings vloeitempo oor die waterval en in die stroomaf rigting van die rivier – altyd verby die keerwal en die Augrabies-waterval sal vloei, wanneer daar $30m^3/s$ of meer water in die rivier is. Die hidrologiese rekord dui daarop dat daar geleenthede in die onlangse verlede was toe vrystellings van die stroomop damme en abstraksies van die rivier die vloeitempo in die rivier tot onder $30m^3/s$ verminder het. As die vloeitempo in die rivier bo $30m^3/s$ styg, sal die bykomende vloei gedeel word tussen die kragsentrale en die rivier vloei oor die valle, tot tyd en wyl die tempo van afleiding van water uit die keerwal na die kragstasie sy maksimum van $38m^3/s$ bereik. Op hierdie vlak sal die afleiding van die water in die kragstasie beperk wees tot $38m^3/s$ deur middel van beheer poorte/hekke in die afneem struktuur.

'n Belangrike oorweging in die ontwerp van die keerwal is dat dit nie sal lei tot verhogings in stroomop watervlakke wat nadelige ïnvloed sal uitoefen op besproeiing of dreinering infrastruktuur van die mid-stroom of vloedvlakte gebiede nie, sowel as plase en wingerde stroomop vanaf die keerwal.

Die konstruksie van die keerwal sal watervlakke stroomop verhoog, maar wiskundige modellering - water berekeninge in 'n numeriese simulasie van die verskeie rivierkanale - dui daarop dat verhoogde watervlakke vir 'n afstand van sowat 3km stroomop sal uitbrei van die keerwal. Dit staan bekend as die ‘invloedlimiet’ van die keerwal. Dit sal stroomaf van enige bewerkte gebiede wees en dui aan dat die keerwal nie nadelig besproeiing of dreinering infrastruktuur in hierdie gebiede sal beïnvloed nie.

OMGEWINGSIMPAK

Landbou, plant – en diere omgewings impakte

Vlak gronde en dorheid beperkinge beteken dat die projek area nie tans gebruik word vir landbou nie, en dit is onwaarskynlik dat dit in die toekomsvir landbou doeleindes sal gebruik word. Die grootste gedeelte projek infrastruktuur word beplan op grond tipe ‘Ag2’. Grond van hierdie grond tipe is vlak, rooi, sanderige grond geleë op onderliggende rots en word as Hutton, Mispah en Glenrosa grondvorms geklassifiseer volgens die Suid-Afrikaanse grondklassifikasiestelsel. Meeste van die projek area het 'n land vermoë klassifikasie van 8 op die kategorie skaal, met: Klas 7 - nie-bewerkbare, lae potensiaal weiding, en 8 - Nie-bruikbare woestyn. Die rotsagtige kloof gebiede word as klas 8 geklassifiseer. Minimale impak op landbou word verwag.

Die Riemvasmaak studie area is nie in ‘n bree sin plantkundig sensitief nie, en behalwe vir die Laer Gariep Alluviale plantegroei, is die flora en plantegroei nie bedreig nie. Die omgewing is goed bewaar en is duidelik 'woestyn' agtig. Die ekosisteem is grootliks ongeskonde en ongestoord. Rehabilitasie, en vier jaar van monitering word aanbeveel as versagtende maatreëls, om die impak op die botaniese omgewing te verminder.

Die projek gebied is een van die 122 ‘Belangrike Voël Gebiede’ in Suid-Afrika. Dit behou beduidende komponente van Nama Karoo fauna biodiversiteit, en as gevolg van sy nabyheid aan die AFNP, vorm dit 'n belangrike komponent van die beskerming van hierdie bioom. Min amfibieërs kom voor in die Benede-Oranjerivier area, met 'n maksimum van 12 spesies wat waarskynlik in die projek area voorkom. Geen amfibieërs is endemies aan die streek nie, en geen amfibieërs van ‘bewaring kommer’ bestaan in die gebied nie. Die mees sensitiewe habitatte vir amfibieërs is meerjarige poele water in die Oranjerivier palaeokanale voorkom. Reptiel diversiteit in die streek is veel groter, met 57 spesies wat voorkom in die streek. Twee akkedisse wat naby-endemies aan die streek is beslaan die gebied, maar geen reptiele van ‘bewaring kommer’ is teenwoordig nie. Die mees sensitiewe habitatte vir reptiele is uitgestrekte rotsagtige gebiede, veral in die "Canyon Sone'. Die meerderheid van die soogdiere teenwoordig in die projek area is klein tot medium-grootte. Soogdiere gebruik al habitatte in die streek, en die rots skeure en krake van die ‘Canyon streek’ vorm nesgebiede vir groot getalle van vlermuise wat 'n belangrike rol speel in die beheer van insekplae oor die besproeide landerye, sowel as die beheer van swart-vlieg peste wat 'n beduidende ekonomiese impak in die streek het.

Impak op akwatiese ekologie

Die rivierloop het ‘n verwysings verandering ondervind vanaf sy oospronklike toestand in terme van biologiese diversiteit en integriteit (vis, makro-ongewerweldes en oewerplantegroei) sowel as in-stroom en oewerhabitat verander, meestal as gevolg van getransformeerde hidroliese toestande voort gebring deur bestuur van stroomop reservoirs, en die gehalte van water impak vanuituit landbou besproeiing en 'n paar klein mynbou aktiwiteite in die streek.

Selfs al is daar is die transformasie en vernederende eienskappe teenwoordig in die rivier, bly die algehele ekologiese belang en sensitiwiteit (EBS) hoog. Die oppervlak kwaliteit van die water oor die hele opname area word beskou as goed, met die water stelsel wat 'n verskeidenheid van sensitiewe akwatiese makro-invertebrate taxa ondersteun. Dit is dus noodsaaklik dat die projek-verwante aktiwiteite wat besoedeling aan die oppervlak waters kan veroorsaak deur nadelige uitvloeisels en afloopwater streng bestuur en beheer word. Gereelde monitering van watergehalte wat vroeë identifisering van besoedeling in staat stel, word aanbeveel. Hoewel 'n natuurlike versperring bestaan (in die vorm van die Augrabies-waterval) wat migrasie in die nabyheid van die voorgestelde keerwal werf verteenwoordig, word hierdie gedeelte van die rivier beskou as relatief produktief en daarom word dit aanbeveel dat oorweging insluitend voorsiening vir vis beweging in die keerwal gemaak word.

Impakte op die sosio-ekonomiese omgewing

Die projek sal na verwagting tussen 150 tot 200 tydelike geleenthede verskaf gedurende die konstruksiefase, terwyl tussen vyf en tien permanente geleenthede tydens die projek se operasionele fase sal geskep word. Die meeste van die geleenthede sal gegun word aan die omliggende gemeenskappe, wat die algemene loon van sommige huishoudings gedurende die konstruksiefase sal verhoog. Dit behoort 'n positiewe impak op die plaaslike ekonomie te hê, soos die verhoging van die besteebare inkomste. RCT sal baat as gevolg van dividend en huurinkomste wat verband hou met die projek. Daarbenewens het die REIPPPP vereis dat die gemeenskap trusts in die breër areas geïdentifiseer en ondersteun word deur die hernubare energie-projekte.

Die Augrabies-waterval is 'n beduidende toeriste aanlokking in die streek. Die hoof aantrekkingskrag in die reservaat is die Augrabies-waterval self, 'n 56 m hoë waterval met verskeie besigtiging dekke sowel as die park ontvangs in die nabye omgewing. Wysigings aan die ‘sin-van-bestaan’ gekoppel aan ‘n plek, deur die impak op die estetiese aard van die gebied en 'n toename

in geraas en stof wat verband hou met die konstruksie-aktiwiteite, sal ‘n negatiewe impak op toerisme in die gebied hê. Die natuurlike skoonheid van die gebied; feitlik geen 'onnatuurlike' geraas en die algemene ''vrede en rustigheid' wat verband hou met die AFNP, is beduidende aantreklikhede vir toeriste aan die park asook vir mense wat die rivier vir onstpanning benut.

Terwyl 'n minimum van 30m³/s altyd gekanaliseer sal word na die waterval, op voorwaarde dat die vloei van die rivier nie onder hierdie vlak is nie, sal daar altyd 'n effense afname in die hoeveelheid water wees wat die valle bereik bo vloei van 30m³/s in die rivier. Die kwessie van die verminderde vloei en die impak wat dit kan hê op toerisme vir die park en toeriste se ervaring van die watervalle is geïdentifiseer deur verteenwoordigers van die AFNP wat die belangrikheid van die valle opgemerk het as ‘n toeriste aantrekking. In 'n pogingom die belangrikheid van die volume van die water wat oor die valle beweeg, op die aantal besoekers aan die park te meet, is data versamel vanaf Maart 2009 tot Augustus 2013 in vergelyking met die vloei van data vir dieselfde tydperk. Data vanaf Februarie 2010 en Januarie 2011 toon dat in tye van hoë vloei, die aantal besoekers aan die park aansienlik verhoog, dui op 'n dui op 'n direkte korrelasie tussen die vlak van die vloei en die aantal besoekers aan AFNP. Dit moet egter in ag geneem word dat hierdie spesifieke tye die Oranjerivier in vloed was. Vanaf September 2011 tot Augustus 2013, terwyl die vloei relatief konsekwent gebly het, was daar nog steeds opvallend toename in besoekers aan die park rondom die Augustus en September tydperke, waarskynlik veroorsaak deur seisoenale toeriste op pad na Namakwaland, en Desember en Januarie, 'n hoogtepunt vakansie tydperk. Die toename in toeriste in hierdie tye kan ook gesien word in 2009 en 2010. Hierdie bevindinge dui daarop dat, terwyl daar waarskynlik 'n groot instroming van toeriste sal wees in soortgelyke tydperke, dat die watervlakke en volume water oor die waterval, oor die algemeen, nie die aantal besoekers aan die park bepaal nie.

Die impak van seismisiteit

Werk deur die Raad vir Geowetenskap, het die voorkoms van 'n onlangse aardbewing swerm in die Augrabies-gebied, wat begin het in Julie 2010 en bestaan uit voortdurende klein seismiese trillings, gedefinieer en geïdentifiseer. Geen gebeure van soortgelyke grootte, groter as 3,0 het plaasgevind sedert 2012 nie, en nie 'n enkele geval van groter as 5.0 (ongeveer Gewysig Mercalli intensiteit skaal VI) het tydens die geldeenheid van die swerm plaasgevind nie. Nietemin sal alle strukture ontwerp moet word om bewings ten minste gelyk aan die maksimum omvang dusver aangeteken tydens die swerm, te weerstaan. Dit word beskou as hoogs onwaarskynlik dat holtes/gate kan vorm, want die plaaslike geologie is nie bevorderlik vir die vorming van holtes of sinkgate nie (dit is nie dolomitiese terrein nie).

Impak op erfgenis, geraas en visuele benadering

Grafte is geïdentifiseer en vermy in die plasing van infrastruktuur. Sensitiewe erfenis kenmerke is geïdentifiseer, maar die projek infrastruktuur sal geen gevolge hê daarop nie.

Geraasvlakke tydens die dag wat verband hou met die konstruksie-aktiwiteite word verwag om beperk tot 'n gebied binne 500 meter van die aktiwiteit te wees. Die assessering kan nie reseptore wat binne 2000 meter van die voorgestelde ontwikkeling identifiseer nie, met die uitsondering van die kraglyn. Die kriteria soos uiteengesit in die SANS10328: 2008 riglyne dui aan 'n lae potensiaal vir geraas impak tydens operasies, te danke aan die feit dat infrastruktuur meestal begrawe sal wees.

Daar kan min gedoen word om visuele impak tydens die konstruksie tydperk te verminder, maar tydens die operasie sal visuele impak minder belangrik wees aangesien die meeste infrastruktuur begrawe sal word, en baie daarvan sal toenemend minder belangrik word soos rehabilitasie in werking tree. Daar sal egter sekere infrastruktuur komponente sigbaar wees dwarsdeur die projek se bestaan, naamlik: Die afleiding keerwal-en afname struktuur (wat geleë is in en aangrensend die rivierkanaal), die substasie en die 132 kV oorhoofse lyn (op die aangrensende privaat eiendom).

Aardvorming van die stortings materiaal sal help in die vermindering van die visuele impak van die gedeponeerde materiaal, en dit is moontlik dat met die verloop van tyd, sal sommige van die materiaal weg geskuif word en gebruik word vir konstruksie doeleindes êrens anders. Met die uitsondering van die oewerplantegroei langs die dam, wat sal help om die afneem struktuur uit sig te hou, is die plantegroei in die gebied yl, en sal dit nie ‘n beduidende bydra tot die versteking van die projek infrastruktuur hê nie.

Die impakte wat geïdentifiseer was vir die verskillende fases van die projek is soos volg:

Impak Studie	Impak Beskrywing	Sonder Versagting	Met Versagting
"NO-GO" / BESTAANDE GRONDGEBRUIK IMPAKTE			
Akwatiese ekologie	Agteruitgang van die ekologiese toestand van die rivier	**Hoog -**	**NVT**
Plante	Bewaring van bestaande plantegroei	**Hoog +**	**NVT**
Diere	Bewaring van diere	**Hoog +**	**NVT**
Visuele	Die positiewe visuele impak van die bewaring van die omgewing binne die AFNP en omgewing, in 'n natuurlike toestand en met geen visuele indringers.	**Hoog +**	**NVT**
KONSTRUKSIE FASE IMPAKTE			
Landbou	Vermindering van landbou-potensiaal	**Laag -**	**Laag -**
Akwatiese ekologie	Vernietiging van akwatiese habitat om keerwal konstruksie te akkommodeer	**Laag -**	**Laag -**
	Vernietiging van die plaaslike riviere en sytakke om die konstruksie van die boonste hoofdam te akkommodeer	**Laag -**	**Laag -**
	Vermindering van water volume wat oor die Augrabies-waterval vloei, om die hidro skema te akkommodeer	**Laag -**	**Laag -**
	Besoedeling van oppervlak water wat lei tot die verlies van sensitiewe biota	**Gem -**	**Laag -**
	Impak op oewerplantegroei wat lei tot afname in filtrasie van afloop water	**Gem -**	**Laag -**
	Biodiversiteit impak as gevolg van oewerplantegroei verlies	**Gem -**	**Laag -**
	Verminderde vloedstelsels kapasiteit a.g.v verwydering van oewerplantegroei	**Gem -**	**Laag -**
	Verhoogde erosie tempo, grondverdigting en verwydering van plantegroei	**Gem -**	**Laag -**
	Erosie en vernietiging van die habitat van gebergde bogrond en versteuring daarvan	**Gem -**	**Laag -**
Plante	Impak as gevolg van die bou van die inname fasiliteit	**Hoog -**	**Gem -**
	Impak as gevolg van die bou van die voorkeur opsie kanaal roete	**Hoog -**	**Gem -**
	Die krag kamer ligging met hoofdam en 'tailrace'.	**Hoog -**	**Gem -**
	Transmissielyn roetes (Boesmanland Ariede Grasveld en Laer Gariep Broken Veld - kabel dieselfde kanaal as hoofstroom)	**Laag -**	**Laag -**
	Transmissielyn roetes (Boesmanland Ariede Grasveld - kabel langs toegangspad)	**Gem -**	**Laag -**
Diere	Verlies aan amfibiese diversiteit	**Laag -**	**Laag -**
	Verlies aan reptiel diversiteit	**Gem -**	**Laag -**
	Verlies aan voël diversiteit	**Gem -**	**Laag -**
	Verlies aan soogdier diversiteit	**Gem -**	**Laag -**
	Verlies aan species van 'bewarings kommer' diversiteit	**Gem -**	**Laag -**
	Impak op fauna as gevolg van hul habitat en die verlies aan habitat	**Baie Hoog -**	**Mod -**
	Ekologiese impak van stof	**Laag -**	**Laag -**
	Ontwrigting van diere deur verhoogde geraasvlakke	**Gem -**	**Gem -**
	Chemiese besoedeling	**Gem -**	**Laag -**
Erfenis	Potensiële impakte op grafte	**Hoog -**	**Mod -**
	Potensiële impak op die kulturele landskap	**Gem -**	**Laag -**
	Potensiële impak op die erfenis van die AFNP	**Gem -**	**Laag -**
Geraas	Algemene geraas	**Gem -**	**Laag -**

Impak Studie	Impak Beskrywing	Sonder Versagting	Met Versagting
Sosio-ekonomies en toerisme	Land verlies	**Laag -**	**Laag -**
	Tydelike ontwrigting van boer aktiwiteite	**Laag -**	**Laag -**
	Werk geleenthede	**Gem +**	**Hoog +**
	Stimulering van klein, dedium en mikro-ondernemings	**Laag +**	**Gem +**
	Toename in informele handelaars	**Laag +**	**Laag +**
	Toerisme	**Gem -**	**Laag -**
	Verspreiding van siektes	**Laag -**	**Laag -**
	Verhoogde Parongelukke	**Gem -**	**Laag -**
	Toename in die stof	**Laag -**	**Laag -**
	Brandgevaar	**Gem -**	**Laag -**
	Verhoogde kriminele aktiwiteite	**Laag -**	**Laag -**
	Toenemende druk op die bestaande maatskaplike infrastruktuur	**Gem -**	**Laag -**
Visuele	Die potensiële negatiewe visuele impak van die projek komponent op sensitiewe visuele reseptore in die nabyheid van die infrastruktuur of aktiwiteite.	**Gem -**	**Gem -**
Seismisiteit	Impak van seismisiteit op konstruksie	**Laag -**	**Laag -**
IMPAKTE TYDENS WERKINGS FASE			
Akwatiese ekologie	Transformasie van akwatiese habitat stroomop van die keerwal	**Laag -**	**Laag -**
	Versperring te binnestroom migrasie	**Laag -**	**Laag -**
	Skepping van kunsmatige habitat in episodiese waterlope	**Laag -**	**Laag -**
	Besoedeling van oppervlak water features	**Laag -**	**Laag -**
	Erosie van die waterloop by uitloop (tailrace)	**Laag -**	**Laag -**
	Besoedeling van oppervlak waters	**Laag -**	**Laag -**
	Eksotiese plantegroei indringing	**Laag -**	**Laag -**
	Habitat transformasie en sedimentasie op akwatiese habitatte	**Gem -**	**Laag -**
Plante	Impak op die estetika van die projek area as 'n bewaringsgebied	**Gem -**	**Laag -**
Diere	Verlies van dier biodiversiteit	**Laag -**	**Laag +**
	Verlies aan spesies van ‘bewaring kommer’ (SBK)	**Hoog -**	**Gem -**
	Bekendstelling van Alien fauna	**Laag -**	**Laag -**
	Bedreigings deur die beweging van diere	**Hoog -**	**Gem -**
	Impak op fauna as gevolg van hul habitat en die verlies aan habitat	**Laag -**	**Laag -**
	Impak as gevolg van veranderinge in hidrologie	**Gem +**	**NVT**
	Verhoogde stofvlakke	**Laag -**	**Laag -**
	Geraasbesoedeling	**Laag -**	**Laag -**
Sosio-ekonomiese en Toerisme	Finansiële voordele aan die Riemvasmaak Gemeenskap Trust	**Hoog +**	**Hoog +**
	Stigting van 'n breë gemeenskapsbelange Trust	**Hoog +**	**Hoog +**
	Stimulering van klein, medium en mikro-ondernemings	**Gem +**	**Gem +**
	Toename in informele handelaars	**Laag +**	**Laag +**
	Werksgeleenthede	**Gem +**	**Hoog +**

Impak Studie	Impak Beskrywing	Sonder Versagting	Met Versagting
	Verhoogde Padongelukke	**Laag -**	**Laag -**
	Verbeterde Energie Produksie	**Gem +**	**Gem +**
Visuele	Die potensiële negatiewe visuele impak van die projek komponent op sensitiewe visuele reseptore in die nabyheid van die ondergrondse infrastruktuur.	**Gem -**	**Gem -**
Seismisiteit	Algemene impak van seismisiteit op die bedrywighede fase	**Gem -**	**Laag -**
ONTMANTELING FASE IMPAKTE			
Diere	Verhoogde stofvlakke	**Laag** -	**Laag** -
	Geraasbesoedeling	**Gem** -	**Laag** -
Sosio-ekonomiese en Toerisme	Verhoogde werksgeleenthede	**Gem** +	Hoog +
	Stimulering van klein, medium en mikro-ondernemings	Laagw +	**Gem** +
Visuele	Die potensiële oorblywende visuele impak van die projek komponent na die sluiting van die kragsentrale.	**Gem** -	**Laag** -
KUMULATIEWE IMPAKTE			
Impak Studie	**IMPAK BESKRYWING**	**Sonder versagting**	**Met versagting**
Dierkundige	Omliggende grondgebruik impak op fauna	**Hoog -**	**NVT**
	Verlies aan habitat	**Hoog -**	**NVT**
Erfenis	Potensiële impakte op argeologiese erfenishulpbronne	**Gem -**	**NVT**
	Potensiële impakte op grafte	**Hoog -**	**NVT**
	Potensiële impak op die kulturele landskap	**Gem -**	**NVT**
Sosio-ekonomiese en Toerisme	'n Toename in besteebare inkomste	**Hoog +**	**Hoog +**
	Verbeterde toegang tot maatskaplike dienste	**Hoog +**	**Hoog +**
	Verhoogde Padongelukke	**Hoog +**	**Hoog +**
	Stof toename	**Gem -**	**Laag -**
Visuele	Die potensiële bydrae van die projek infrastruktuur tot die toename van soortgelyke ontwikkelings in die streek.	**Gem -**	**Laag -**

Gevolgtrekkings

Daar word verwag dat baie van die botaniese en fauna impakte verminder sal word met finale ingenieurswese ontwerp wat bewus sal wees van die bevindinge en sensitiwiteite wat in hierdie verslag, sowel as die effektiewe bestuur van die terrein tydens konstruksie, en die benutting van toepaslike rehabilitasie tegnieke na konstruksie wat als verduidelik word in hierdie verslag. Aangesien die meeste infrastruktuur ondergronds sal wees, sal die grond oppervlak behoorlik gerehabiliteer word, en mettertyd sal die getuienis van die ondergrondse infrastruktuur toenemend moeiliker raak om te bepaal, soos blyk uit die Drakensberg Pomp-Skema Hidro-elektriese projek.

Na konstruksie voltooi is, sal daar duidelike bogrondse infrastruktuur wees. Die keerwal is 'n lae struktuur en kan nie beskou word as aanstootlik nie, aangesien die oorloop gedeeltes daarvan met water sal oorvloei vir die meeste van die tyd, en net die weerskante mure sigbaar sal wees. Die afneem werke sal aansienlik wees, maar met simpatieke en versagtende argitek ontwerp kan 'n struktuur van hierdie aard, tesame met hergroei van die oewerplantegroei versteur deur die konstruksie, kan die struktuur minder duidelik geword. Daar sal bogrondse strukture in vorm van die hoof dam, insluitend 'n krag kamer toegang struktuur en 'n substasie wees. Daar is potensiaal in hierdie baie afgeleë gebied om dit te posisioneer sodat die sigbaarheid van almal, behalwe die hoogste uitkykpunte in die gebied, beperk is en dat dit onwaarskynlik sal wees dat hulle sigbaar van die Nasionale Park sal wees.

'n Minimum vloei vereiste van 30 kubieke meter per sekonde in die Augrabies-waterval in af sal nooit in drang gestel word deur afleiding van water deur die hidro-projek nie, en die afleiding van water in die projek sal geleidelik gedoen word soos die vloeitempo in die rivier styg. Dit is onwaarskynlik dat hierdie die visuele skouspel van die valle aansienlik sal verminder, aangesien dit moeilik is vir die normale besoeker om te onderskei tussen vloei tussen 30 en ongeveer 70 kumeks.

Ons is nie onsensitief teenoor die probleme wat dusver deur die Parkeraad en die bestuur van die Augrabieswaterval Nasionale Park bekend gemaak nie. Ons erken dat die konstruksie van die projek uitgevoer moet word met die grootste sorg moontlik, en indien die versagtende maatreëls in hierdie verslag konsekwent en ywerig geïmplementeer word, glo ons dat hierdie fase van die projek met 'n minimale ongerief vir die Park en sy besoekers onderneem kan word. Dit is veral so omdat toegang tot die noordelike dele van die Park vir 'n aantal jare al beperk word tot Parkeraad personeel , en die gewone besoeker dus nie beduidend verontrief sal word deur die projek nie.

Soos voorheen bespreek, wanneer konstruksie voltooi is en die terrein gerehabiliteer word, is ons van die mening dat die invloed daarvan op die Park gering sal wees. Die invloed daarvan op die plaaslike bevolking en die land as 'n geheel sal egter aansienlikke positiewe impakte hê, en ons moedig SANParke aan om hierdie projek te beskou as in die nasionale belang, en nie as 'n bedreiging vir die integriteit van die Park.

Gevolglik, onder die voorwaardes in hierdie verslag beskryf en die gepaardgaande Konsep Omgewingsbestuursplan, beveel ons aan dat die projek ontvang Omgewingsmagtiging in voldoende tyd toegeken word vir dit om in Rondte 5 van die Departement van Energie se hernubare energie bodproses oorweeg te word.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDICES

The Appendices to this report are in Volume 3a, and are as indicated below.

APPENDIX	DESCRIPTION
A	Acceptance of Final Scoping Report and Plan of Study
B	Description of the Public Participation Process
C	Register of Interested and Affected Parties
D	Issues and Response Trail
E	Original Copies of Letters Received
F	Impact Rating Methodology
G	Land Ownership, Management and Zoning
H	SAHRA Review of the HIA

1 INTRODUCTION

RVM 1 Hydro Electric Power (Pty) Ltd (RVM) intends to construct a run-of-river hydroelectric power station on the Orange River on the farm Waterval (Remainder of Farm no. 497) and Portion 1 of Farm no. 498 (known as Riemvasmaak), north of the Augrabies Falls, approximately 32km north west of Kakamas in the Northern Cape Province of South Africa. The power station will have an installed generating capacity of 40 megawatts (MW), and an estimated annual energy output of 235 gigawatt-hours (GWh).

The general location of the project is shown on Figure 1.1.

1.1 Hydroelectric power generation

Hydroelectricity is generated by the use of the gravitational force of flowing water to rotate a turbine, which in turn rotates a generator that converts the mechanical, rotational energy into electrical energy. The power that can be generated is proportional to the height through which the water falls to the turbine (the head), the volume of water flowing through the turbine per unit of time (the flow rate), and the efficiency of the turbine / generator combination at converting rotational energy into electrical energy.

1.1.1 Dammed hydroelectric power projects

Most large hydroelectric power projects (HPPs) create the head necessary to drive the turbine / generator sets by constructing a dam across a river, which stores water and releases it into the power house, and then back into the river downstream of the dam wall. This type of project has a significant effect on the flow regime of the river, especially in rivers where the flow rate varies between wet and dry seasons: natural low flows are increased by the need to generate electricity continuously, while natural high flows are reduced because of the need to store water in the dam for use during dry periods. The HPPs at the Gariep Dam (installed capacity 360MW) and Vanderkloof Dam (installed capacity 120MW), both on the Orange River upstream of the Augrabies Falls, are examples of projects of this type. In addition to generating electricity, both dams regulate the flow in the Orange River to provide water for the many irrigation schemes along the river. The dams also provide a measure of security for downstream areas against the destructive effects of all but the largest floods in the rivers.

Dammed HPPs do not directly consume water – they are non-consumptive water users - because the water used to generate electricity is returned to the river a short distance downstream of the dam, but large impounding reservoirs in hot climates do lose considerable volumes of water by evaporation from the open water surface of the reservoir.

1.1.2 Run-of-river hydroelectric power projects

The proposed RVM HPP will be a run-of-river project. This type of project uses the natural drop in elevation along the course of a river to create the driving head, and usually has a very much smaller storage capacity than a dammed scheme, or no storage at all. Where storage is required it is usually created by a low weir across the river, which diverts a portion of the natural flow of the river to the power house, and then back into the river a short distance downstream of the diversion weir. Since it is necessary to construct some form of open or closed conduit (a canal or water conduit) to convey the water from the diversion weir to the power house, a site with a short, steep drop in elevation - a natural geological feature such as a waterfall, or an existing dam or weir - is preferred in order to limit the length and cost of the conduit, which is referred to as the headrace. However, such sites are limited in South Africa (see Chapter 7 – Alternatives - for details), thereby limiting the opportunity for run-of-river HPPs. Available sites need to be investigated for their electricity generating potential, with due concern for environmental and social issues that may arise.

Run-of-river projects do not affect the flow regime of the river as much as dammed schemes. The diversion capacity is generally not sufficient to materially affect seasonal high flows in the river, and provisions are usually made in the project operating rules to minimise the effects of the diversion at seasonal low flow rates.

Run-of-river HPPs are also non-consumptive water users, and the evaporative losses from the very much smaller open water surfaces of the weir impoundment, offtake, open (canal) headrace and head pond, are also very much reduced compared to a dammed scheme.

1.2 Background to the Study

This project was initially the subject of a Basic (Environmental Impact) Assessment, and a Draft Basic Assessment Report was released for public review in January 2013. The project was subsequently increased in size due to a change in the Department of Energy's policies, and the environmental assessment upgraded to a full Scoping and Environmental Impact Assessment (EIA) process during the first half of 2013. A Draft Scoping Report was released for public review in July 2013. The Final Scoping Report was submitted to the Department of Environmental Affairs in September 2013 and accepted in October 2013. The Environmental Assessment Practitioner (EAP) for the project up until the end of the Scoping Phase was Aurecon. The EAP for the Environmental Impact Assessment (EIA) phase is EOH Coastal & Environmental Services (CES).

1.3 The Environmental Impact Assessment Process

1.3.1 Public Participation

This section provides a summary of public participation activities, some of which have already been undertaken and some of which are planned for the future, between March and June 2015.

Post-Scoping activities (undertaken)

1. Update of the database / register of interested and affected parties (I&AP).
2. Fixing new notices at the site, and information notices at public places and retail outlets in the area.
3. Distribution of new registration forms and Background Information Documents (Afrikaans and English) to:
   (a) Schools, libraries, municipal public places
   (b) Key local stores and cafés around the project area.
   (c) The local farmers' associations.
   (d) Local and district municipality offices.
4. Stakeholder Letter One: Notification letter sent to the entire I&AP database, notifying existing I&APs of the new environmental impact assessment practitioner, the EIA process and requesting them to re-register
5. Compilation of an issues and comments trail from comments received from interested and affected parties.
6. Registration of new I&APs and recording their comments into the issues and comments trail.

Draft Environmental Impact Assessment activities

1. Send out a reminder to all I&APs to register if they have not done so.
2. Set-up focus group meetings with key stakeholder groups including:
   (a) Kai !Garib Local Municipality
   (b) ZF Mgcawu District Municipality
   (c) Department of Water and Sanitation
   (d) Department of Agriculture, Forestry and Fisheries
   (e) Department of Public Works and Roads
   (f) Farmers Associations
   (g) South African National Parks
   (h) Tourism Kakamas

(i) Northern Cape Nature Conservation

3. Deliver the Draft EIA Report to key I&APs, all the public places and commenting authorities in the Kai! Garib Municipal area.

1. Augrabies Falls National Park Information and Reception desk, Main Park Building, Augrabies Falls National Park
2. Marchand Kai !Gariep Municipal Office Clinic Street, Marchand Town
3. Augrabies Kai Gariep Municipal Office 199 Tin Sirgel/Crescent, Augrabies Town
4. Kakamas Library 28 Voortrekker Street, Kakamas
5. CES web site http://www.cesnet.co.za/public-documents.html

4. Upload the Draft EIA Report to the EOH CES website
5. Stakeholder Letter Two: Forward DEIAR notification letter to the entire I&AP database, notifying all I&APs where the DEIAR will be available and clarifying the comments period.
6. Conduct public open house events on the following dates:
   (a) Tuesday, 5 May 2015, 08:00 – 12:00. Vredesvallei / Molopo Community Hall, Vredesvallei.
   (b) Tuesday, 5 May 2015, 14:00 – 18:00. RVM Mission Station Community Hall, Riemvasmaak.
   (c) Wednesday, 6 May 2015, 15:00 – 18:00. Marchand Community Hall, Marchand
   (d) Thursday, 07 May 2015, 14:00 - 18:00. Kalahari Gateway Hall, Voortrekker Street, Kakamas.
7. Stakeholder follow-up regarding the DEIAR and comments.
8. Update the I&AP database/ register and record all comments and concerns raised by I&APs.
9. Compilation of a series of notes of the focus group meetings and public open house events. Distribute the notes of the meetings to all registered I&APs and incorporate it into Final Environmental Impact Assessment Report (FEIAR).
10. Inform all registered interested and affected parties of the availability of the FEIAR.

Final Environmental Impact Assessment activities (Undertaken)

1. Make changes to the Draft EIA Report as a result of comments from I&APs.
2. Prepare responses to all comments received from I&APs as Volume 5 – Comment and Response Report.
3. Submit the Final EIAR, EMPr, specialist reports and Comment and Response Report to DEA.

Amended Final Environmental Impact Assessment activities (in progress)

1. Provide SANParks with a copy of all documents relating to the project with a request that they review and comment on them.
2. Prepare responses to DEA's rejection letter as an Addendum Report, and make necessary amendments to the Final EIA Report.
3. Inform all registered I&APs of the availability of the Amended Final EIA Report, the Addendum Report and the new Economic Assessment specialist report.
4. Make necessary changes to the reports as a result of I&AP comments and submit to DEA.

1.3.2 EIA Regulations and Listed Activities

The EIA process (Figure 1.2) is guided by Regulations made in terms of Chapter 5 of the National Environmental Management Act, No. 107 of 1998, as amended (NEMA), published as Government Notice No R.982 in Government Gazette No 38282 of 4th December 2014. The Regulations set out the procedures and criteria for the preparation, submission, processing and consideration of

applications, and decisions on applications, for the environmental authorisation of activities.

Three Listing Notices - lists of activities that require an environmental authorisation before they may be commenced – were published on 4th December 2014 as Government Notice Numbers R.983, R.984 and R.985. Projects that involve activities listed in GNR.983 and 985 require a Basic Assessment to be undertaken (that is, projects considered to have limited environmental impacts), while projects that trigger activities listed in GNR 984 require a full Scoping and Environmental Impact Assessment to be undertaken (that is, projects that are considered to have impacts that are significant in extent and duration).

This assessment commenced at a time when Regulations published on 18th June 2010 were in force. These were GN R.543, R.544, R.545 and R.546. The project will continue under these Regulations. The 2010 Listed Activities considered to be applicable to the project are listed in Table 1.1.

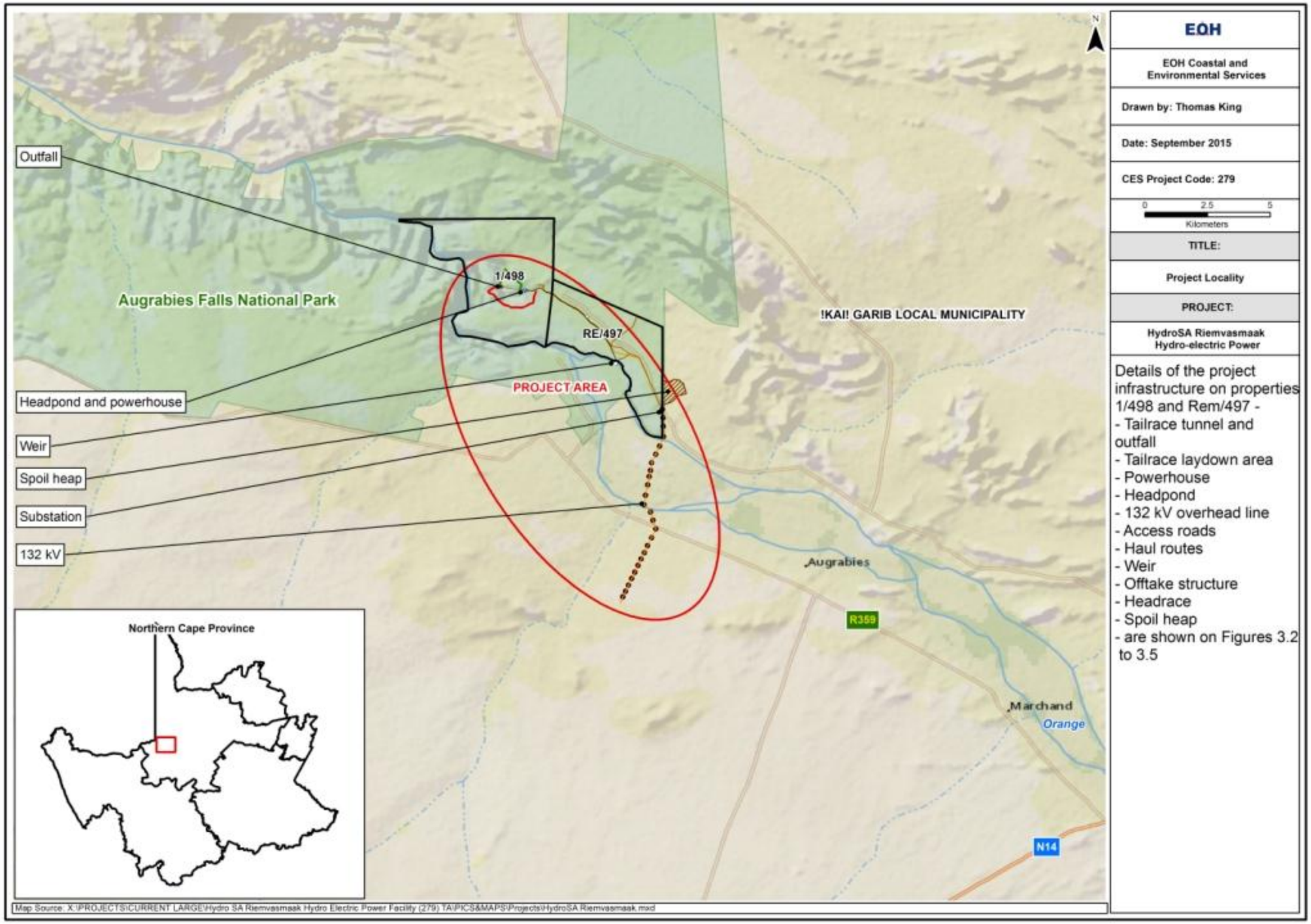

Figure 1.1: Project locality
Note: The relationship between the boundaries of the properties on which most of the project infrastructure will be constructed - 1/498 and Rem/497 – with the actual boundaries of Augrabies Falls National Park is discussed in section 2.6 – Land Ownership, Management and Zoning.

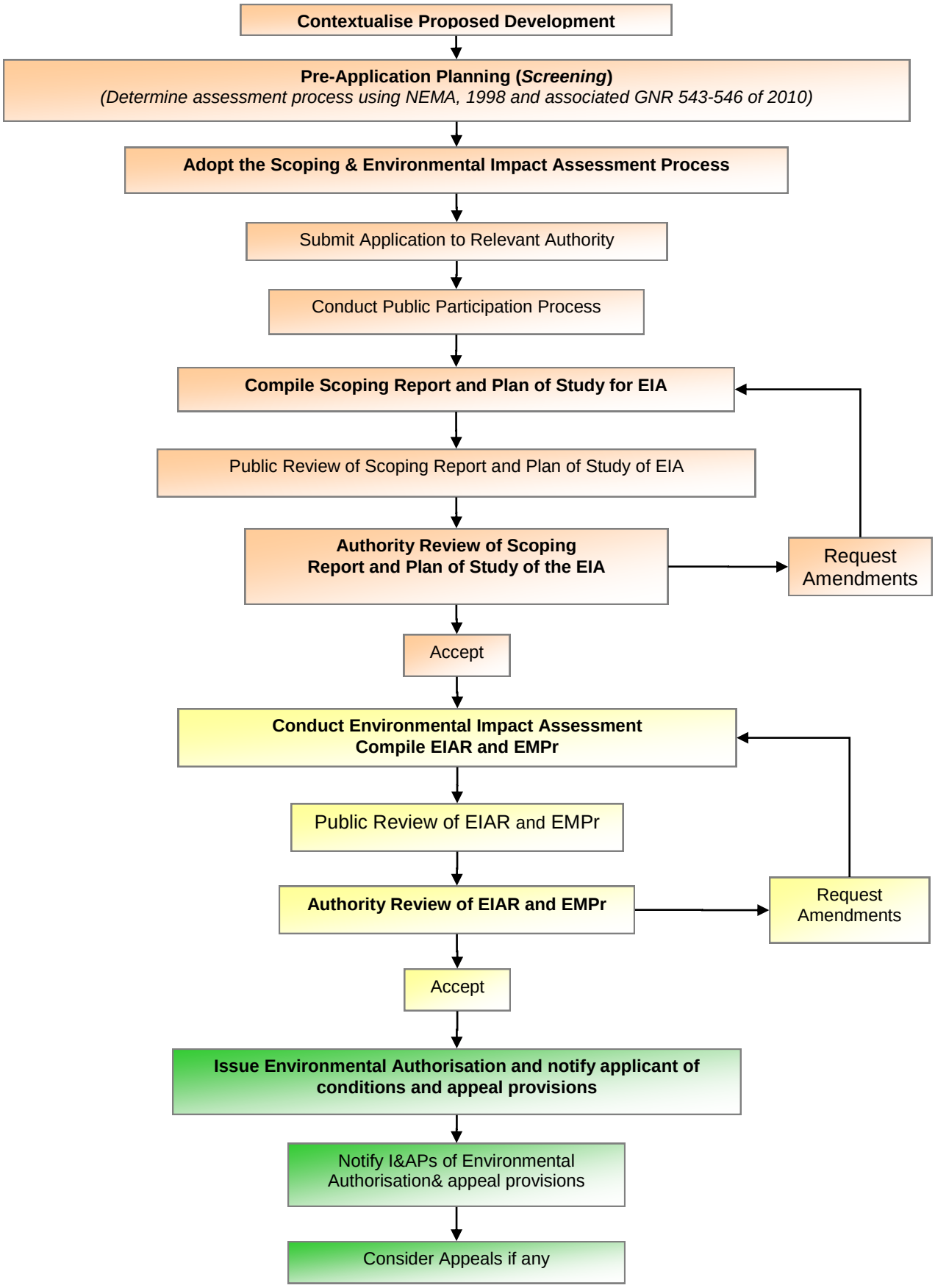

Figure 1.2: The EIA process under current legislation (NEMA 1998, as amended.
Scoping Phase (orange), Environmental Impact Assessment Phase (yellow), and Environmental Authorisation Phase (green).

It is important to note that in addition to the requirements for an authorisation in terms of the NEMA, there are additional legislative requirements that need to be considered prior to commencing with the activity. For example: the National Heritage Resources Act (Act No 25 of 1999), the National Water Act (Act No 36 of 1998), the NEM: Waste Act (Act No 59 of 2008), White Paper on Energy Policy for South Africa (Energy White Paper), White Paper on Renewable Energy Policy (Renewable Energy White Paper), the Integrated Energy Plan for the Republic of South Africa (March, 2003), etc. These requirements are discussed further in Chapter 4 of this report.

Table 1.1: Listed Activities triggered by the project

Activity Number	Description of Activity	Element of Project
GN R.544, 18 June 2010 (requires a Basic Assessment)		
9	The construction of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of water, sewage or storm water – i. with an internal diameter of 0,36 metres or more; or ii. with a peak throughput of 120 litres per second or more, excluding where: a. such facilities or infrastructure are for bulk transportation of water, sewage or storm water or storm water drainage inside a road reserve; or b. where such construction will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse.	The proposed project requires water conveyance infrastructure which will comprise an underground conduit to convey water from the diversion weir to the headpond / penstock the headrace). The maximum flow rate in the headrace will be 38 m³/s. The headrace will comprise two rectangular culverts approximately 4.0m high by 3.5m wide, and 4.6 km long. Water will be discharged from the underground power station back into the river via the tailrace, which will be a horseshoe-shaped tunnel of nominal diameter 6m, about 675m long.
10	The construction of facilities or infrastructure for the transmission and distribution of electricity: i. outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts; or ii. inside urban areas or industrial complexes with a capacity of 275 kilovolts or more.	A transmission line of 33 kV (buried – about 7km long) and 132 kV (overhead – about 9km long) capacity will be required to evacuate power from the proposed facility to connect with the national grid.
11	The construction of: i. canals; ii. channels; iii. bridges; iv. dams; v. weirs; vi. bulk storm water outlet structures; vii. marinas; viii. jetties exceeding 50 square metres in size; ix. slipways exceeding 50 square metres in size; x. buildings exceeding 50 square metres in size; or xi. infrastructure or structures covering 50 square metres or more where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.	Infrastructure within 32 m of a watercourse will comprise: • A low diversion weir across the Orange River • An offtake structure between the diversion weir and the start of the headrace, • A short portion of the headrace • The downstream portion of the tailrace. All other infrastructure will be farther than 32m from any watercourse.
18	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand,	During construction of the proposed hydropower project more than 5 cubic metres of material will be removed from the

Activity Number	Description of Activity	Element of Project
	shells, shell grit, pebbles or rock from i. a watercourse; ii. the sea; iii. the seashore; iv. the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater- but excluding where such infilling, depositing, dredging, excavation, removal or moving i. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or ii. occurs behind the development setback line.	Orange River for the construction of certain project elements such as the weir and offtake structure. The construction of these elements, as well as the construction of the powerhouse and tailrace, will involve the deposition of more than 5 cubic metres of material into the active river channel and the dry gorge channel.
GN R.545, 18 June 2010 (requires Scoping plus EIA)		
1	The construction of facilities or infrastructure for the generation of electricity where the electricity output is 20 megawatts or more.	The proposed project consists of a hydropower station with installed generating capacity of 40 MW.
10	The construction of facilities or infrastructure for the transfer of 50 000 cubic metres or more water per day, from and to or between any combination of the following: i. water catchments, ii. water treatment works; or iii. impoundments, excluding treatment works where water is to be treated for drinking purposes.	DEA considers the headpond of the proposed project to be an impoundment into which water will be conveyed from the intake structure.
GN R.546, 18 June 2010 (requires a Basic Assessment)		
4	The construction of a road wider than 4 metres with a reserve less than 13,5 metres: a. In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and Northern Cape provinces: i. In an estuary; ii. Outside urban areas, in: aa A protected area identified in terms of NEMPAA, excluding conservancies; bb National Protected Area Expansion Strategy Focus areas; cc Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority dd a. Sites or areas identified in terms of an International Convention; ee Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; ff Core areas in biosphere reserves; gg Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve;	Access roads to the proposed hydropower station will be approximately 6m in width and will be situated in areas that are within the boundaries of the AFNP, or which are zoned in terms of the internal AFNP Management Plan (2012).

Activity Number	Description of Activity	Element of Project
	hh Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined. iii. In urban areas: aa Areas zoned for use as public open space; bb Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose. Cc Seawards of the development setback line or within urban protected areas.	
12	The clearance of an area of 300 square metres or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation. a. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; b. Within critical biodiversity areas identified in bioregional plans; c. Within the littoral active zone or 100 metres inland from high water mark of the sea or an estuary, whichever distance is the greater, excluding where such removal will occur behind the development setback line on erven in urban areas.	Clearance of vegetation for the project as a whole will exceed 300 square metres, and the vegetation cover will constitute at least 75% indigenous vegetation.
13	The clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, except where such removal of vegetation is required for: 2. the undertaking of a linear activity falling below the thresholds mentioned in Listing Notice 1 in terms of GN No. 544 of 2010. c. Northern Cape and Western Cape: i. In an estuary; ii. Outside urban areas, the following: (aa) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (bb) Sites or areas identified in terms of an International Convention; (cc) Core areas in biosphere reserves; (dd) Areas within10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; (ee) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined.	Clearance of vegetation for the project as a whole will exceed 1 hectare, and the vegetation cover will constitute at least 75% indigenous vegetation. **Note:** There is no equivalent Listed Activity in the 2014 Listing Notices: see section 1.4 following. Application for this Activity can be withdrawn.
14	The clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative	Clearance of vegetation for the project as a whole may exceed 1 hectare, and the

Activity Number	Description of Activity	Element of Project
	cover constitutes indigenous vegetation, except where such removal of vegetation is required for: 1. purposes of agriculture or afforestation inside areas identified in spatial instruments adopted by the competent authority for agriculture or afforestation purposes; 2. the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the activity is regarded to be excluded from this list.	vegetation cover will constitute at least 75% indigenous vegetation. **Note:** There is no equivalent Listed Activity in the 2014 Listing Notices: see section 1.4 following. Application for this Activity can be withdrawn
16	The construction of: (i) jetties exceeding 10 square metres in size; (ii) slipways exceeding 10 square metres in size; (iii) buildings with a footprint exceeding 10 square metres in size; or (iv) infrastructure covering 10 square metres or more where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.	The footprint area of project-related infrastructure within 32 m of a watercourse - • A low diversion weir across the Orange River • An offtake structure between the diversion weir and the start of the___14 headrace, • A short portion of the headrace • The downstream portion of the tailrace. - will exceed 10 square metres.

1.4 NEMA EIA Regulations 2014

Section 53(1) of the Environmental Impact Assessment Regulations, 2014, made in terms of the National Environmental Management Act (107 of 1998) and published on 4th December 2014 as GN R.982, specifies that:

> *An application submitted in terms of the previous NEMA regulations and which is pending when these Regulations take effect … , must despite the repeal of those Regulations be dispensed with in terms of those previous NEMA regulations as if those previous NEMA regulations were not repealed.*

However, sections 53(2) and 53(3) specify that

> *(2) If a situation arises where an activity or activities, identified under the previous NEMA Notices, no longer requires environmental authorisation in terms of the current activities and competent authorities identified in terms of section 24(2) and 24D of the National Environmental Management Act, 1998 (Act No. 107 of 1998) or in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), and where a decision on an application submitted under the previous NEMA regulations is still pending, the competent authority will consider such application to be withdrawn.*
>
> *(3) Where an application submitted in terms of the previous NEMA regulations, is pending in relation to an activity of which a component of the same activity was not identified under the previous NEMA notices, but is now identified in terms of section 24(2) of the Act, the competent authority must dispense of such application in terms of the previous NEMA regulations and may authorise the activity identified in terms of section 24(2) as if it was applied for, on condition that all impacts of the newly identified activity and requirements of these Regulations have also been considered and adequately assessed.*

Table 1.2 compares the requirements of the 2010 and 2014 EIA Regulations, from which it is clear that:

1. There are no Listed Activities in GN R.985 (2014 EIA Regulations, Listing Notice 3) that are equivalent to two Listed Activities in GN R.546 (2010 EIA Regulations, Listing Notice 3), which are:
   (i) Listed Activity 13: The clearance of an area of 1 hectare or more of vegetation where 75%

or more of the vegetative cover constitutes indigenous vegetation, etc, etc, etc: and

(i) Listed Activity The clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation, etc, etc, etc.

2. There are no Listed Activities relevant to the proposed project in the 2014 Listing Notices that are not covered by equivalent Listed Activities in the 201 Listing Notices.

Table 1.2: Comparison of NEMA EIA Regulations 2010 and 2014

NEMA EIA Regulations 2010	NEMA EIA Regulations 2014	Conclusions
GN R.544 (BA)	**GN R.983 (BA)**	
(9) The construction of facilities or infrastructure exceeding 1000 metres in length for the bulk transportation of water, sewage or storm water, etc, etc	(9) The development of infrastructure exceeding 1000 metres in length for the bulk transportation of water or storm water, etc, etc **Or possibly** (depending on how the water supply to a hydroelectric power station is regarded) **–** (10) The development and related operation of infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes	Equivalent Listed Activities No new Listed Activities No action necessary
(10) The construction of facilities or infrastructure for the transmission and distribution of electricity: i. outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts; or	(11) The development of facilities or infrastructure for the transmission and distribution of electricity – (a) outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts	Equivalent Listed Activities No new Listed Activities No action necessary
(11) The construction of: v. weirs; etc, etc where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.	(12) The development of – (v) weirs, where the weir, including infrastructure and water surface area, exceeds 100 square metres in size. (x) buildings exceeding 100 square metres in size. (xii) infrastructure or structures with a physical footprint of 100 square metres or more. Where such development occurs: (a) Within a watercourse etc etc	Equivalent Listed Activities No new Listed Activities No action necessary
(18) The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from i. a watercourse etc etc	(19) The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal, or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from: (i) a watercourse etc etc	Equivalent Listed Activities No new Listed Activities No action necessary
GN R.545 (Scoping+EIA)	**GN R.984 (Scoping+EIA)**	
(1) The construction of facilities or infrastructure for the generation of electricity where the electricity output is 20 megawatts or more.	(1) The development of facilities or infrastructure for the generation of electricity from a renewable resource where the electricity	Equivalent Listed Activities No new Listed Activities No action necessary

NEMA EIA Regulations 2010	NEMA EIA Regulations 2014	Conclusions
	output is 20 megawatts or more.	
(10) The construction of facilities or infrastructure for the transfer of 50 000 cubic metres or more water per day, from and to or between any combination of the following: etc etc etc	(11) The development of facilities or infrastructure for the transfer of 50,000 cubic metres or more water per day, from and to or between any combination of the following: etc etc etc	Equivalent Listed Activities No new Listed Activities No action necessary
GN R.546 (BA)	**GN R.985 (BA)**	
(4) The construction of a road wider than 4 metres with a reserve less than 13,5 metres: ….. etc etc etc	(4) The development of a road wider than 4 metres with a reserve less than 13.5 metres. ….. etc etc etc	Equivalent Listed Activities No new Listed Activities No action necessary
(12) The clearance of an area of 300 square metres or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation. ….. etc etc etc	(12) The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. … etc etc etc	Equivalent Listed Activities No new Listed Activities No action necessary
(13) The clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation ….. etc etc etc	No equivalent Listed Activity	Application for authorisation can be withdrawn
(14) The clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation ….. etc etc etc	No equivalent Listed Activity	Application for authorisation can be withdrawn
(16) The construction of: . `jetties exceeding 10 square metres in size; . slipways exceeding 10 square metres in size; . buildings with a footprint exceeding 10 square metres in size; or . infrastructure covering 10 square metres or more where such construction occurs within a watercourse or within 32 metres of a watercourse, … ….. etc etc etc	(14) The development of – (i) canals exceeding 10 square metres in size. (ii) channels exceeding 10 square metres in size. (v) weirs, where the weir, including infrastructure and water surface area, exceeds 10 square metres in size. (x) buildings exceeding 10 square metres in size. (xii) infrastructure or structures with a physical footprint of 10 square metres or more. Where such development occurs: (a) Within a watercourse ….. etc etc etc	Equivalent Listed Activities No new Listed Activities No action necessary

1.5 The Environmental Impact Assessment Practitioner

Dr Ted Avis – Managing Director: EOH Coastal and Environmental Services
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Telephone: +27 21 045 0015
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1.5.1 Expertise of the consultancy and the EAP

"Since our inception in 1990, CES has grown into one of the largest independent environmental consulting firms in Southern Africa. In addition to our recognition as leading environmental impact assessment (EIA) practitioners in South Africa, our track record for preparing environmental and social impact assessments (ESIA), and for the delivery of a wide range environmental advisory services is recognised across Africa, where we have completed many studies to international standards.

CES has offices in Grahamstown, East London, Port Elizabeth, Cape Town and Johannesburg, South Africa. CES Mozambique Lda is a registered legal entity and a wholly-owned subsidiary of CES (Pty) Ltd, with offices in Maputo, Mozambique. CES is registered as an Environmental Practitioner with the Mozambican authorities. All our staff are well qualified in the biological, social and environmental sciences (almost all consultants have postgraduate qualifications)."

Dr A.M. (Ted) Avis (Director) – EAP; Contributing author; Reviewer

Ted is a leading expert in the field of Environmental Impact Assessments, having project-managed numerous large-scale ESIAs to international standards (e.g. International Finance Corporation). Ted was principle consultant to Corridor Sands Lda for the development of all environment aspects for the US$1billion Corridor Sands Project. He has managed ESIA studies and related environmental assessments of similar scope in Kenya, Madagascar, Egypt, Malawi, Zambia and South Africa. Ted has worked across Africa, and also has experience in large scale Strategic Environmental Assessments in southern Africa, and has been engaged by the International Finance Corporation (IFC) on a number of projects.
Ted was instrumental in establishing the Environmental Science Department at Rhodes University whilst a Senior lecturer in Botany, based on his experience running honours modules in EIA practice and environmental science. He was one of the first certified Environmental Assessment Practitioners in South Africa, gaining certification in April 2004. He has delivered papers and published in the field of EIA, Strategic Environmental Assessment and Integrated Coastal Zone Management and has been a principal of CES since its inception in 1990, and Managing Director since 1998.
Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled "Coastal Dune Ecology and Management in the Eastern Cape". Ted is also a professional member of the South African Council for Natural Scientific Professionals (since 1993).

Mr Bill Rowlston – Contributing author; Reviewer

Bill holds a First Class Honours degree in civil engineering from the University of Salford, England (1971). He worked for 25 years for the South African Department of Water Affairs and Forestry, where he contributed to the development of the National Water Policy and the National Water Act, and compiled and edited the National Water Resource Strategy, First Edition (2004), much of which he wrote.
Bill joined CES as a Director in 2007. In addition to working as project manager and water resources specialist on a number of large ESIAs and ESHIAs in South Africa and in other African countries, he has undertaken environmental and social due diligence studies, compliance reviews and audits for a range of proposed and operational projects:

- Due diligence review of previous environmental assessments for a proposed peaking power station in the Kafue Gorge, Zambia;
- Environmental and social compliance review for a large agro-industrial conglomerate in South Africa;
- Environmental and social compliance reviews for a proposed solar photovoltaic and two proposed solar concentrated power projects in South Africa;
- Environmental and social compliance reviews for two hydroelectric power projects, one in Zambia and one in Zimbabwe;
- Environmental and social compliance review for a proposed copper mine in north-west Zambia;
- Two annual environmental and social audits for an operational heavy minerals mine in Mozambique;
- Corporate environmental and social compliance review for an electrical power transmission and distribution corporation in north-west Zambia;
- A two-year programme of environmental and social monitoring for the rehabilitation of the Rift Valley Railway in Kenya and Uganda.

All reviews were conducted against the requirements of relevant national legislation, the Equator Principles, the International Finance Corporation Performance Standards on Environmental and Social Sustainability, and the IFC Environmental, Health and Safety Guidelines.

Mr Thomas King – Contributing author

Thomas holds a BSc degree with specialisation in Zoology from the University of Pretoria and an Honours degree in Biodiversity and Conservation from Rhodes University. As part of his Honours degree, Thomas was trained in Geographical Information Systems (GIS) and Community Based Natural Resource Management (CBNRM) in addition to the required biological sciences courses. His honours thesis investigated the rate at which Subtropical Thicket recovers naturally after heavy grazing by ostriches (*Struthio camelus).* At CES he has been involved in EIAs for numerous wind energy developments, a chicken rearing facility, numerous mining developments and has fulfilled the role of Environmental Control Officer (ECO) at the Kenmare Heavy Minerals mine in northern Mozambique. Thomas is primarily responsible for GIS related work at CES.

Dr Eric Igbinigie – Contributing author

Eric holds a PhD in Environmental Biotechnology and is a registered Professional Natural Scientist (Pr.Sci.Nat.) and a certified EMS ISO 14001:2004 Auditor (IRCA). He is a seasoned environmental consultant with project experience in different industry sectors across Africa including mining, oil and gas, agro-industry and water/effluent treatment facilities in developing countries financed by Equator Principles Financial Institutions such as the IFC, AFC, FMO, SWEDFUND, DEG and AfDB. Eric's areas of expertise include Scoping and EIA, Integrated Waste Management Plans, IFC Performance Standards on E&S Sustainability (2012) compliance assessment, EMS ISO 14001:2004, Waste and Wastewater Impact/Quality Assessment, Bioremediation and Environmental Site Assessment (Phases I, II & III). Apart from his considerable experience as an environmental consultant, he has an outstanding record in research and academic scholarship with Rhodes University, yielding sound scholarly publications and a patented technology for the rehabilitation and re-vegetation of coal mined land, which is currently in use in South Africa.

Mr Anton Hough

Anton is a Social Scientist primarily involved in Socio-Economic Baseline Studies (SEBS), Social Impact Assessments (SIAs), Social Management Plans and Resettlement Action Plans (RAPs). His academic qualifications and accomplishments include a Masters in Sociology obtained from the University of Stellenbosch in South Africa, and three published ISI-listed academic publications in Social Dynamics, the South African Geographical Journal and the South African Journal of Science. At EOH CES, some of the projects with which he has been involved to date include several large on-going RAPs primarily in Mozambique, as well as many SIAs and SEBS (both report writing and reviewing) in countries such as Liberia, Democratic Republic of the Congo (DRC), Cameroon, Sierra Leone, Mozambique and South Africa. Most of his work is performed to

the International Finance Corporation (IFC) Performance Standards. Prior to his work at EOH CES, he gained experience as a Social Scientist in the mining and community development sectors, but also the socio-environmental arena; in which capacity he published web-based articles on socio-environmental issues in Africa.

Ms Ayanda Zide

Ayanda holds a BSc in Botany, Microbiology and Chemistry and a BSc (Hons) in Botany where her thesis focused on identifying and characterising galls and gall forming insects and associated pathogens (fungi) on the mangrove species *Avicennia marina*. Courses in her honours year included Diversity Rarity and Endemism (DRE), Pollination Biology, Estuarine Ecology, Rehabilitation Ecology, a Stats course and a short GIS course. Her research interests lie in biological invasion, conservation, rehabilitation ecology, plant biotechnology and water research. Ayanda conducts vegetation impact assessments that guide proposed developments to reduce their impacts on sensitive vegetation. As part of these surveys she identifies and maps the vegetation communities and areas of high sensitivity. She has worked as a botanical assistant on the Lesotho Highlands Development Authority botanical baseline survey, on renewable energy projects and has conducted groundtruthing surveys for developments in the Eastern Cape.

1.6 Specialist Team

Specialist Study	Affiliation	Name of Lead Specialist(s)
Heritage	ACO Associates	Jayson Orton and Lita Webley
Aquatic Ecology	EnviRoss CC	Mathew Ross
Visual	MetroGIS (Pty) Ltd	Lourens du Plessis
Botanical	Bergwind Botanical Surveys and Tours CC	David J. McDonald
Socio-economic and Tourism	ACER (Africa) Environmental Consultants	Duncan Keal
Noise Assessment	M^2 Environmental Connections CC	M. de Jager S. Weinberg
Faunal Assessment	Private	Professor William Branch
Agricultural Assessment	Private	Johann Lanz
Geotechnical Study	Council for Geoscience	FDJ Stapelberg
Economic Assessment	Imani Development (SA) (Pty) Ltd	Professor Gavin Maasdorp Mr Frank Sturgess

2 DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 The Physical Environment

2.1.1 Climate

Temperature

In the hottest summer months (January and February) the average daytime temperature at the project site is 41°C, but highs of 46°C have also been recorded. At night, temperature drops to an average of about 25°C (SANParks, 2015).

In winter, the average daytime temperature fluctuates around 20°C. At night, temperatures are 0°C on average but are regularly below freezing (SANParks, 2015).

Rainfall

The average annual rainfall at the project site is 124 mm with most rainfall falling between November and April - summer and autumn. Summer rainfall usually falls in short, heavy bursts, accompanied by spectacular thunderstorms and strong winds. Winter rains are gentle and last 1-3 days resulting in a flower paradise (SANParks, 2015).

The arid climate of the project area, in which open-surface evaporation far exceeds precipitation, indicates that the Weinert climatic N value[2] (Weinert, 1980) is approximately 45, and that in situ chemical decomposition of basic rock due to weathering does not occur under the prevailing climatic conditions. Under these conditions soil, and to a large extent also weathered gravel and cobbles occurring in this area, are products of physical weathering; that is, they are material deposited after transportation either by alluvial or colluvial processes.

2.1.2 Topography and surface drainage

The majority of the project site is located in what can be classified as a “nearly flat plain”, with local relief of less than 5 metres and large areas nearly horizontal. However, near the north-western end of the headrace, in the headpond area, this changes to a rolling plain with relatively low relief of between 5 and 100 metres and no steep slopes, and eventually to a low but steep escarpment of roughly 100 metres in height at the site of the tailrace outfall. A number of shallow, ephemeral / episodic streams, which drain the higher-lying terrain to the north-east of the site, cross the headrace route in a south-western direction. These channels transport and deposit sandy alluvial material over parts of the route of the headrace.

The diversion weir, the approximate route of the headrace, the site of the headpond and route of the tailrace, are shown on a digital terrain model in Figure 2.1, which shows the general topographic features of the project site, with spot heights in metres above mean sea level. The route of the headrace (black line adjacent to the secondary Orange River channel) indicates denuded topography and a very slight surface gradient from the weir to near the headpond (refer to spot heights). Down-slope from the headpond the surface slope to the re-entrance into the Orange River gorge is steep. The plain north-east of the site route gradually rises to higher elevations and steeper topography several hundred metres north-east of the site.

The development of the drainage pattern of the Orange River in the vicinity of Augrabies Falls, which is roughly angular when viewed from above, has been influenced by two sets of steeply inclined geological master joint sets; one with an east-west strike direction and the other with a north-south strike direction. Joint sets lead to differential weathering rates. Lesser northeast-

[2] The Weinert N value was originally developed in southern Africa to describe the weatherability of rocks and the general characteristics of soils formed in different climatic environments. An N value less than 5 (<5) indicates that decomposition – chemical weathering – dominates, while disintegration – physical weathering - dominates in an area with an N value greater than 5 (>5).

southwest and northwest-southeast striking joint sets, as well as two geological faults, also contribute to the drainage pattern in the area. In the project site area in particular the preferential north-south and east-west drainage is, however, not immediately clear, with the exception of the place where the tailrace re-joins the secondary Orange River channel. At that point an acute change in the direction of the erosion channel (a deep gorge) direction from west-east to south-north is apparent. However, in the main Orange River channel (a gorge) the pattern is more apparent.

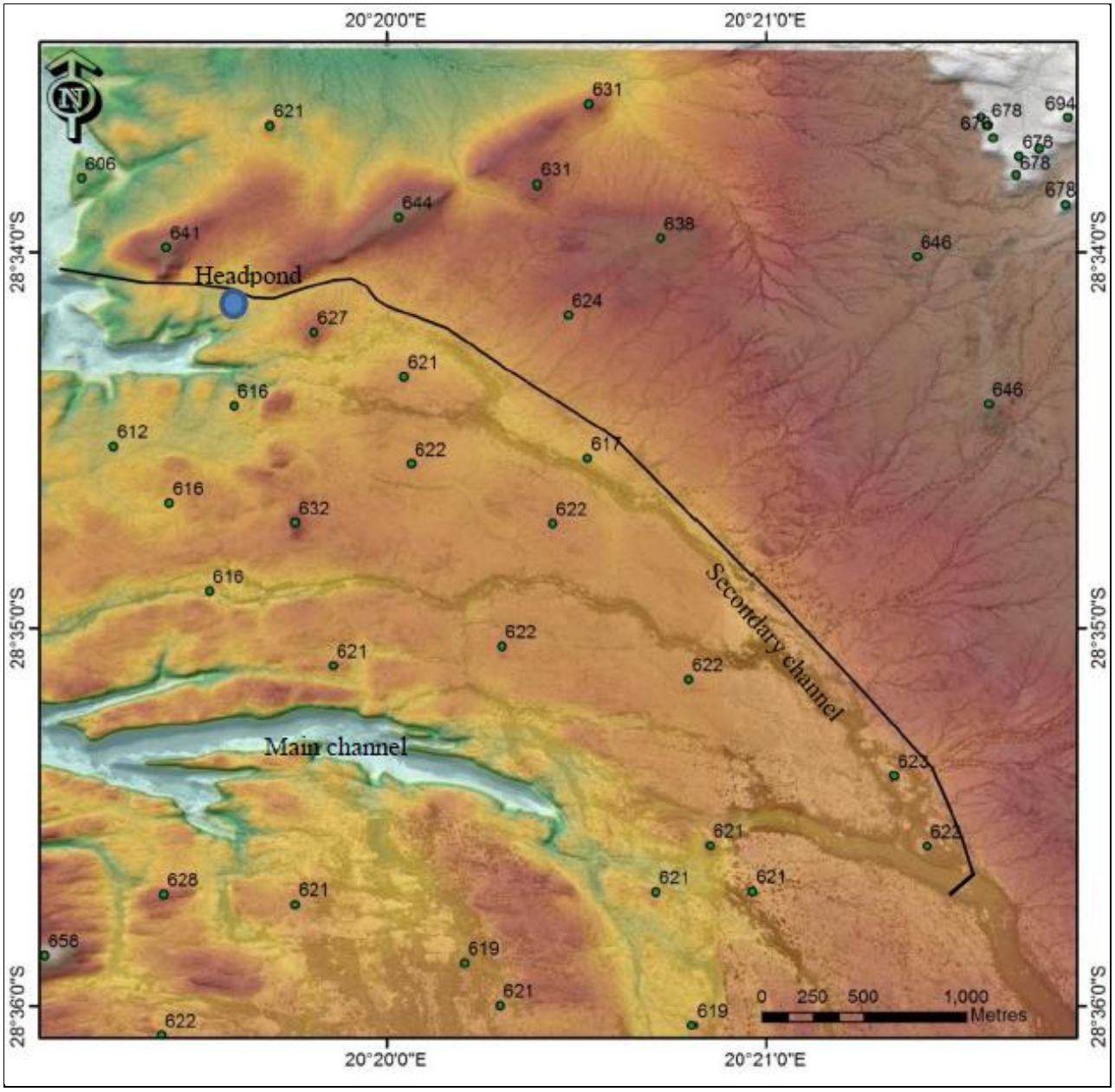


Figure 2.1: Digital terrain model of the project area
Source: Council for Geoscience, 2015, Figure 3

2.1.3 Geology and soils

Rocks in the region are generally highly deformed metamorphosed sedimentary and volcanic rocks intruded by granitoids. The region is further characterised by numerous geological faults and shear zones. The area forms part of the Namaqua Metamorphic Province and lies within the Kakamas terrane of the Gordonia Sub-province of the Namaqua Metamorphic Province. The published 1: 250 000 scale geological map, from which Figure 2.2 is extracted, indicates that the site is located on only one bedrock type, namely the Augrabies Gneiss, and that alluvial cover material occurs over the south-eastern parts of the area.

In Figure 2.1 the route of the headrace and tailrace is shown as a red line. All infrastructural elements are located in the Augrabies Gneiss bedrock (purple polygons with deep red cross-hatching), with alluvial cover (yellow polygons) at the south-eastern end of the headrace. Other geological units in the area are: Riemvasmaak Gneiss (pink polygons); Omdraai Formation (gneiss and quartzite - pale green polygons towards the east); and undifferentiated basic intrusive (gabbroic - dark green polygon marked “Mga” towards the west).

Figure 2.2: Geology of the project area (from 1: 250 000 scale map)
Source: Council for Geoscience, 2015, Figure 4

Augrabies Gneiss

The Augrabies Gneiss is one of a number of intrusive rocks, which includes the Riemvasmaak Gneiss and basic intrusives, all with ages of between 1 300 million years and 1 000 million years. Mineralogically the Augrabies Gneiss consists of quartz, microcline and plagioclase with varying amounts of biotite and hornblende and with rare opaque minerals. The rock is a medium-grained granitoid gneiss and has been partly re-foliated, which lends a distinctive wavy pattern to the fabric and imparts a more massive character than is normal for foliated rock. The texture and fabric are remarkably uniform throughout the outcrop area, which underlies the majority of the south-eastern parts of the Augrabies Falls National Park and extends south-eastwards outside the Park boundaries over a distance of roughly 8 kilometres in the direction of Augrabies village. The rock generally weathers to a greyish colour, is well exposed and forms the rock type into which the main Augrabies Falls and downstream canyon have been cut. An important feature of the Augrabies Gneiss is its tendency to form large exfoliation domes, the most well-known of which is the “Moon Rock” occurring within the Park south of the Orange River.

Alluvium

With regard to alluvial cover over the bedrock, annotations on an unpublished 1: 50 000 scale geological field map (see Figure 2.3 below) indicate that the alluvium extends much further north-westwards along the route of the headrace than indicated on the smaller scale (1: 250 000) published geological map, covering bedrock over the first 3.5 kilometres or so of the headrace route, and for about 1 kilometre south-east of the site of the headpond area. The extent of the alluvial deposits is indicated on the larger scale map by a symbol similar to an elongated “m”.

Comparison of the route of the headrace with Google Earth™ images indicates that unconsolidated sedimentary materials appear to be covering the bedrock over some parts, whilst further along the route to the north-west unconsolidated material appears to be absent, with bedrock (rock outcrop) dominating surface exposure. The sedimentary material may be relatively coarse sand – "gulley wash" or "hillwash" - from the higher ground to the north-east of the headrace route, or loose, fine-grained alluvium deposited during flood events along the Orange River.

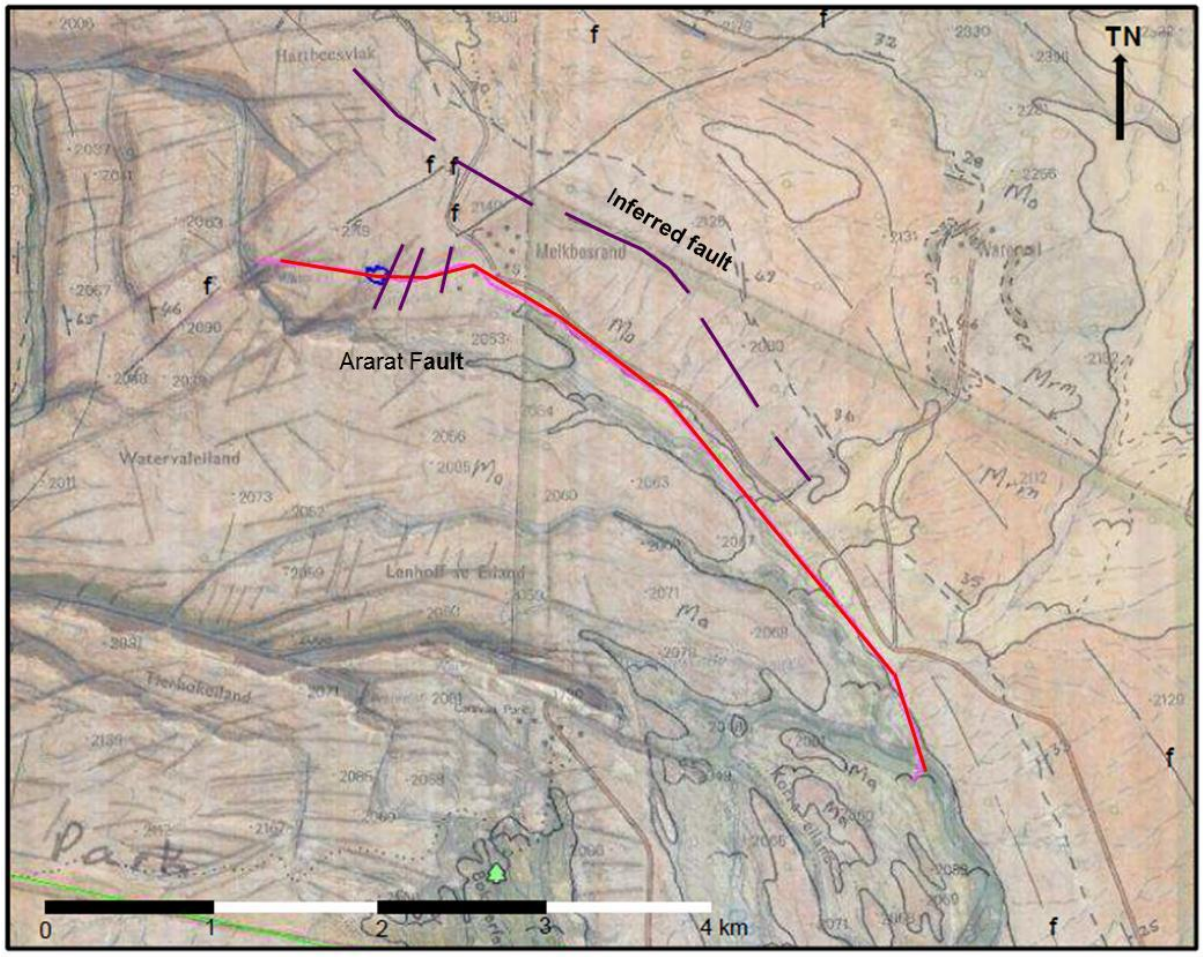


Figure 2.3: Geology of the project area (from 1: 50 000 scale map)
Source: Adapted from Council for Geoscience, 2015, Figure 5. The route of the headrace is shown in red; fault lines in purple.

Structural geology

The 1: 50 000 scale field map also indicates the direction of the master joint sets (short grey linear stripes) mentioned in section 2.1.2, geological fault lines (longer continuous thick grey lines denoted f) and possible/concealed geological faults (longer discontinuous grey lines denoted f).

Faults have similar preferential weathering effects on rocks as joint sets, but may also be subject to re-activation or micro-movements which could cause stress and strain in structures erected in their vicinity. It is therefore important to consider faults when designing and building structures. Two sets of faults could be of importance in the project area:

- The inferred fault shown as a broken purple line in Figure 2.3, which occurs roughly parallel to the route of the headrace and between 250 and 600 metres to the north-east.
- The Ararat Fault (Slabbert and Malherbe 1983), which consists of three roughly parallel lines striking in a north-eastern direction and spaced 250 to 375 metres apart. They cross the route of the headrace near its northern end and in the vicinity of the headpond.

2.2 Flora

2.2.1 Regional Vegetation

The study area falls within the Nama Karoo, which is the third largest biome in South Africa. This biome stretches from the western half of South Africa into the south-eastern parts of Namibia covering 248 284 km^2.

Three bioregions are found within this biome, namely the Upper Karoo Bioregion, Bushmanland Bioregion and the Lower Karoo Bioregion. The Upper Karoo stretches from the eastern Calvinia District in the west to Burgersdorp in the east and from around Douglas and Petrusburg in the north to the Great Escarpment in the south. The Bushmanland Bioregion occurs from the north-eastern part of the Namaqualand area in the west to near Prieska in the east and from around Upington in the north to the Brandvlei/Sak river vicinity in the south. The Lower Karoo Bioregion mainly occupies the basin between the Great Escarpment in the north and the Cape fold mountains in the south, excluding areas of the Albany Thicket in the Eastern Part of the basin (Mucina and Rutherford, 2006).

The Nama Karoo biome is characterised by dwarf shrubs, which are generally less than 1 metre in height, intermixed with grasses, succulents, geophytes and annual forbs occurring on extensive plains. Small trees are found to occur only along drainage lines or rocky outcrops (Mucina and Rutherford, 2006).

Mucina and Rutherford (2009) define the following vegetation types that occur within the project area (Figure 2.4) and from which source these descriptions are derived.

Lower Gariep Alluvial Vegetation

This vegetation type occurs in the Northern Cape Province. It is associated with flat alluvial terraces and riverine islands, occurring on sand banks and terraces within and along the river. This vegetation type is characterised by riparian thicket, where *Ziziphus mucronata, Euclea pseudebenus* and *Tamarix usneoides* are the dominant species, reed beds with *Phragmites australis* and flooded grasslands and herblands. This vegetation type is listed as **Endangered** with a conservation target of 31%, and about 6% is statutorily conserved in the Richtersveld and Augrabies Falls National Park.

Lower Gariep Broken Veld

This vegetation type occurs in the Northern Cape Province from Onseepkans in the west to Keimoes, then resumes at Boegoeberg to near Prieska in the east. It is associated with hills, low mountains and slightly irregular plains but with some rugged terrain: for example, downstream of the Augrabies Falls. Most of this area has an elevation between 400 and 1200m. This vegetation is characterised by sparse vegetation comprised of shrubs and dwarf shrubs which dominate this vegetation type, annual species which are generally noticeable during spring and perennial grasses and herbs. Only *Ruchia pungens* (succulent shrub) is said to be endemic to this vegetation type. This vegetation type is listed as **Least Threatened** with a conservation target of 21%, and only 4% is statutorily conserved in the Augrabies Falls National Park.

Bushmanland Arid Grassland

This vegetation type occurs in the Northern Cape Province, stretching from about one degree of latitude from Aggeneys in the west to Prieska in the east. It occurs in areas characterised by extensive to irregular plains on a slightly sloping plateau, with most areas having an elevation between 600 and 1200m. This vegetation type generally has the character of a semidesert 'steppe' due to its sparsely grassland vegetation dominated by *Stipagrostis species*. Species endemic to this vegetation type include, succulent shrubs *Dinteranthus pole-evansii*, *Larryleachia dinteri*, *Larryleachia marhothii*, *Rushia kenhardtensis* and herb species such as *Lotononis oligocephala* and *Nemesia maxii.* This vegetation type is listed as **Least Threatened** with a conservation target of 21% and is statutorily conserved in Augrabies Falls National Park and Goegab Nature Reserve.

2.2.2 Vegetation at the site

The above three vegetation types as they occur on the project site are described in more detail below.

Lower Gariep Alluvial Vegetation

This vegetation is found on the recently deposited alluvial sediments along the Orange (Gariep) River (Figure 2.4). On the upper banks it forms dense thickets of thorn trees (*Acacia karoo* and to a lesser extent *Acacia erioloba*) with other species such as *Searsia pendulina, Ziziphus mucronata, Maerua gilgii* and *Lycium bosciifolium.* Other prominent trees are *Euclea pseudebenus* and *Tamarix usneoides*. The riverine thickets are often invaded by exotic mesquite (*Prosopis glandulosa* var. *glandulosa*) which forms dense, impenetrable, thorny masses as was seen in the riparian vegetation during the site visit.

In the main river channels and occasionally where water persists in the mainly dry side channels the dominant species is *Phragmites australis* which forms extensive reed-beds.

The reason for the loss of Lower Gariep Alluvial Vegetation in the region is the intense agriculture (mainly table grapes and citrus) on the alluvial soils in the Groblershoop area and mainly west of Upington as far as Augrabies, but also further west along the Orange River where it forms the boundary with Namibia.

In the study area, Lower Gariep Alluvial Vegetation was encountered at the proposed intake or abstraction point and lining the river banks along the upper reaches of the Orange River and its side-channels above the Augrabies Falls; and along the subsidiary river channels north of the falls (Plate 2.1).

Plate 2.1: A side channel of the Orange River at the intake site. The riparian vegetation is Lower Gariep Alluvial Vegetation

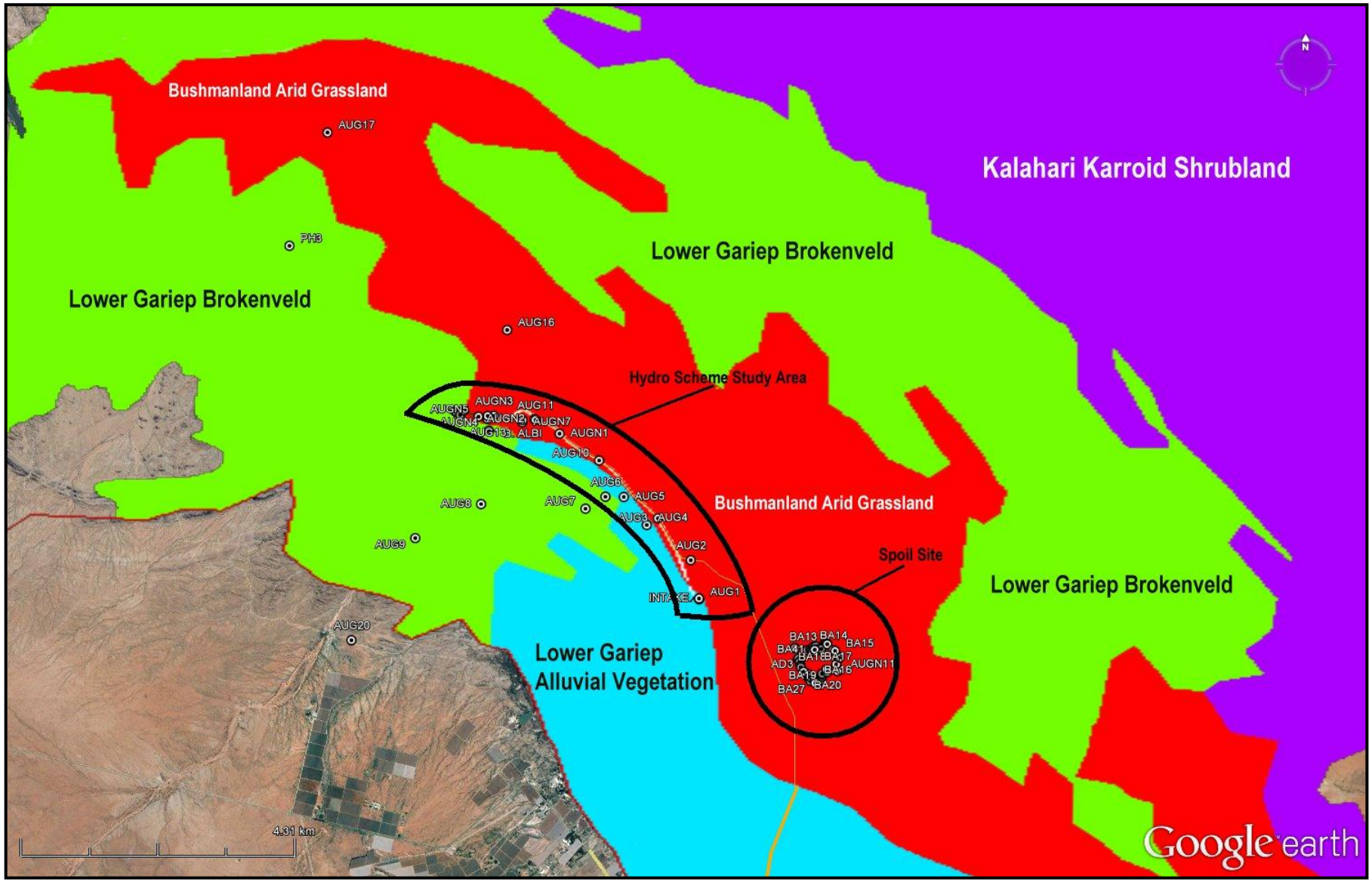


Figure 2.4: Portion of the Vegetation Map of South Africa, Lesotho and Swaziland (Mucina *et al.*, 2005)
Red – Bushmanland Arid Grassland; Mauve –Kalahari Karroid Shrubland; Blue – Lower Gariep Alluvial Vegetation; Green – Lower Gariep Brokenveld. The hydropower study area is enclosed in a black polygon and the spoil site is enclosed in a black circle.

Lower Gariep Broken Veld

Lower Gariep Broken Veld (Figure 2.4 - green) is found on the rugged ultrametamorphic koppies and inselbergs (the Hardeveld) interspersed with low plains, along the Orange (Gariep River) from Onseepkans, including large areas of Riemvasmaak in the west, to as far as Prieska in the east, and from Karos in the north to Marydale in the south. At Augrabies it is found along the gorge below the falls (Mucina *et al*. 2006 in Mucina & Rutherford, 2006). The soils are skeletal and typically Mispah and Glenrosa forms where shallow soil is found over rock.

The vegetation of the Lower Gariep Broken Veld is sparse, dominated by shrubs and dwarf shrubs with perennial grasses. Annual species are more prominent in spring. Tall *Aloe dichotoma* var. *dichotoma* is found as scattered isolated individuals or groups and the ubiquitous black-thorn (*Acacia mellifera* subsp. *detinens*) is common. A list of important plant taxa is provided by Mucina *et al*. (2006).

Plate 2.2: Lower Gariep Broken Veld

Bushmanland Arid Grassland

Bushmanland Arid Grassland (Figure 2.4 - red) is much more widespread than either of the other vegetation types that occur in the study area. It occurs over a wide expanse in the Northern Cape Province from the Bushmanland Basin in the south to the vicinity of the Orange River in the north and from Prieska in the east to Aggeneys in the west (Mucina *et al* 2006). At Augrabies it mixes with Lower Gariep Broken Veld and has numerous plant species in common with the latter type.

One of the striking differences between the Lower Gariep Broken Veld and Bushmanland Arid Grassland is the relatively greater abundance of 'white grasses' (*Aristida* and *Stipagrostis species*) in the latter. Typical Bushmanland Arid Grassland has an open structure with *Acacia mellifera* subsp. *detinens* dominant in the upper stratum and a low stratum of shrubs such as *Zygophyllum rigidum* and white grasses (Plate 2.3).

In the study area, the Bushmanland Arid Grassland is dissected by sandy seasonal 'washes' or streams.

Plate 2.3: A paucity of grasses but low shrubs are common in Bushmanland Arid Grassland

Vegetation of the seasonal watercourses

A site specific community found in the sandy seasonal watercourses or 'washes' also occurs in the area. It is typified by the presence of *Stipagrostis namaquensis* (River Bushman Grass; Kalaharikweek) and *Sisyndite spartea* (Desert Broom). Mature *Acacia erioloba* (Camel-thorn) trees occur occasionally along the washes and *Acacia mellifera* subsp. *detinens* is concentrated along the edges of the 'washes' (Plates 2.4 and 2.5). Other plant species recorded include *Euclea pseudebenus*, *Monechma* cf. *divaricatum*, *Parkinsonia africana*, *Stipagrostis* cf. *obtusa* and *Stipagrostis ciliata*.

Plate 2.4: A sandy seasonal 'wash' with large tussocks of *Stipagrostis namaquensis*
Note the *Acacia erioloba* trees in the background, associated with deep sandy soils.

A well-developed 'wash' is found near the disused 4x4 bush camp. Large *Acacia erioloba* trees are found here together with *Schotia afra* var. *angustifolia* trees, *Acacia mellifera* subsp. *detinens* trees and shrubs of *Monechma genistifolia* (Plate 2.5).

Plate 2.5: Well-developed *A. erioloba*, *S. afra* var. *angustifolia* and *A. mellifera* subsp. *detinens* trees near the disused 4x4 bush camp

2.2.3 Gariep Centre of Endemism

The Gariep Centre (GC) of endemism is named after the Nama word for 'Great River', referring to what is known today as the Orange River. This centre forms part of the Succulent Karoo Region, and is a region of high floristic endemism around the lower reaches of the Orange River (Van Wyk & Smith 2001).

Location

The GC is located in the north-western corner of the Northern Cape, and crosses over into the south-western part of Namibia in a rough 'L' shape. The region stretches from Augrabies, to Riemvasmaak in the east, running past Onseepkans, Goodhouse and Vioolsdrif where it reaches northwards past Ai-Ais (in Namibia) to Aus as the northern most boundary. From there, the northernmost boundary runs towards Lüderitz, from which it runs southwards along the west coast until roughly Port Nolloth, which represents the southernmost boundary. From there the region runs past Steinkopf, Aggeneys and Pofadder back to Augrabies. Figure 2.5 depicts the general boundary of the Gariep Centre. The project area occurs at the boundary of this centre of endemism near Riemvasmaak, shown with a blue dot on the image below (not to scale – only for illustrative purposes).

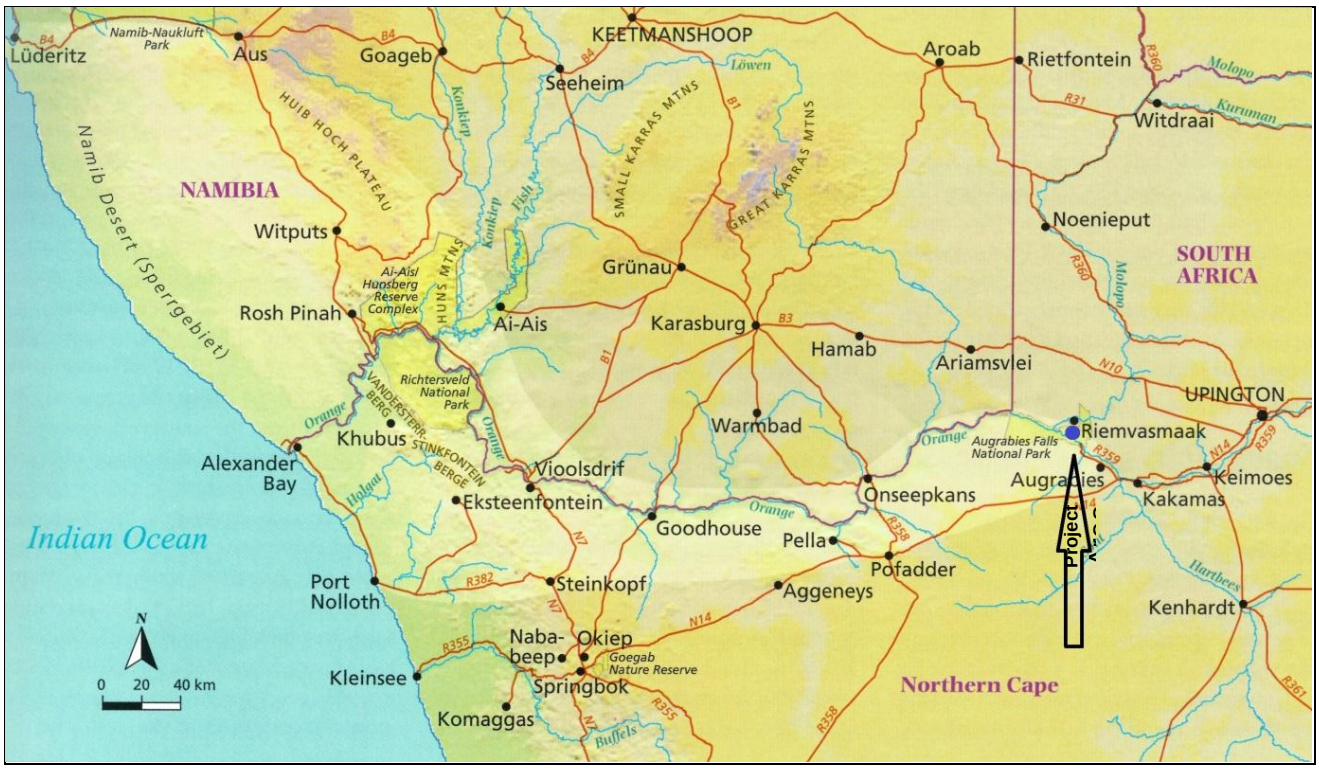


Figure 2.5: Location of the Gariep Centre (GC) of endemism (shown in lighter shading)
The project area is shown at Riemvasmaak with a blue circle, highlighted by the black arrow. Source: Van Wyk & Smith (2001: 39)

Topography throughout this region is highly varied, and includes rugged inselbergs, dunes, sandy and gravel plains, rock strewn mountains and dry river beds (Van Wyk & Smith 2001). A marked feature of this region is the Augrabies Falls, where the Orange River crosses narrow gorges and valleys, running into the coastal plain towards the sea.

Very little rain falls within the region, mainly between May – September of the year. Mean annual rainfall varies from 15-50mm per annum in the Namib Desert (northern regions), to a maximum of 300mm on the Vandersterrberg (within the Richtersveld National Park). Annual rainfall below 15mm is not uncommon (Van Wyk & Smith 2001). Coastal fog is of particular importance in providing sufficient moisture supplement for the vegetation of the region. Temperature along the coast is generally mild, with an annual average between 12 – 17 °C, however the inland parts of this region can be much hotter, with annual daily averages of 32 °C not uncommon (Van Wyk & Smith 2001). Soil types within the region vary from sandy, shallow to stony, with high to low nutrient loads. Soils are generally alkaline, with pockets of saline soils along the coastline.

Flora

The highly variable climate and conditions within this region have led to the evolution of a wide variety of flora and fauna that has adapted to survive in the region. Coupled with the high temperatures and low annual rainfall, the region has come to be predominantly occupied by succulent plant species – specifically xerophytic semi desert shrubland – for which it is renowned. Few trees and shrubs occur within the region, and are mainly confined to the banks of the Orange River, dry watercourses and occasional springs (Van Wyk & Smith 2001).

Conservative estimates of the amount of endemic taxa found within the region have shown the endemism of the region to be remarkably high (Van Wyk & Smith 2001). The GC area has the highest variety of succulent plants on earth, and contains iconic vegetation such as *Aloe pillansii* (UNESCO 2006) and *Pachypodium namaquanum*. Roughly 60% of the succulents within the region are considered endemic (UNESCO 2006). The Succulent Karoo, of which the Gariep Centre forms part, contains an estimated 6356 species, of which 2439 are endemic, representing a 38.4% endemism, one of the highest worldwide (UNESCO 2006). Species surveys of the GC regions

have shown, for example, that of 1615 species, roughly 140 were endemic. Non-succulent endemic or near-endemic genera include *Crocyllis*, *Hexacyrtis*, *Rhyssolobium*, *Sisyndite* and *Xerocladia* (Van Wyk & Smith 2001).

Succulent diversity is also unmatched in other arid biodiversity hotspots, owing to the geological diversity, climate peculiarities and numerous micro-habitats within the region (Van Wyk & Smith 2001). Families well represented by endemic or near endemic species include Mesembryanthemaceae (over 60% endemism), Asclepiadaceae, Asteraceae, Crassulaceae, Eiphorbiaceae and Liliaceae (Van Wyk & Smith 2001). Of the 54 native Zygophyllum (Zygophyllaceae) of South Africa, 17 endemic or near endemics are found within the GC. Such highly variable environmental conditions, climate, soils and topography contribute to produce the extreme level of endemism and variety found within this region, making it one of the most important botanical regions of the world.

Conservation Status

Very little of the Gariep Centre has been formally protected. Protected areas in the GC are the Richtersveld-Ais-Ais Transfrontier National Park, the Orange River Mouth (Ramsar) site, the Richtersveld National Park, the Goegap Nature Reserve near Springbok, and the Augrabies Falls National Park.

2.2.4 Critical Biodiversity Areas

Critical Biodiversity Areas (CBAs) are defined by Berliner *et al*. (2007) as *"terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecosystem functioning".* CBAs are used to inform land-use planning by promoting sustainable development by avoiding loss or degradation of important natural habitats.

The Siyanda District Municipality (now called the ZF Mgcawu District Municipality), in which the project will be located, does not have a Biodiversity Sector Plan in place, and CBAs are not explicitly mentioned in the 2008 Environmental Management Framework for the District.

However, the adjacent Namakwa District Biodiversity Sector Plan (2008) is extremely comprehensive, and maps CBAs and Ecological Support Areas (ESAs) not only for the Namakwa District, but also for parts of adjoining Districts, including West Coast, Pixley ka Seme and ZF Mgcawu. The shapefile[3] for the Namakwa District includes the CBAs and ESAs for the project area.

The Namakwa District Biodiversity Sector Plan describes CBAs as follows:

- CBAs are areas of the landscape that should be maintained in a natural or near-natural state to safeguard the continued existence and functioning of species and ecosystems to ensure that biodiversity conservation targets are met. Biodiversity-compatible land uses and resource uses that maintain the natural state of the area should be considered for these areas;
- ESAs are areas that, although not essential for meeting the biodiversity targets, play an important role in supporting the ecological functioning of CBAs and/or delivering ecosystem services that support socio-economic development. The degree of restriction on land and resource use in these areas is likely to be lower than what is recommended for CBAs.

The CBA map for the project-affected area (Figure 2.6 – extracted from the shapefile for the Namakwa District Diversity Sector Plan discussed above) is used to inform land-use planning (Table 2.1) for the area at a desktop level. It is important to note that there are limitations with these maps:

- Mapping accuracy varies from approximately 1:10 000 to about 1:150 000;

[3] http://bgis.sanbi.org/namakwa/cbas.asp

- The information content of the CBA map is limited by the data and depth of knowledge on the distribution of biodiversity in the district captured in electronic databases. Information for the Siyanda District is very limited;
- The information used to define CBAs is too "coarse" for biodiversity patterns and processes.

Based on the above, it is important that impacted areas are groundtruthed by specialists to produce sensitivity maps at a finer scale.

Table 2.1: Land Management Objectives for the various Critical Biodiversity Areas with relevance to the project site

CBA Category	Land Management Objective	Relevance to project
CBA 1 (T1 on figure 2.6)	• These are ***Natural Landscapes*** with fully intact and undisturbed ecosystems and species • These areas have a high irreplaceability or low flexibility in terms of meeting biodiversity targets and if these areas are lost, biodiversity targets will not be met • These landscapes are at or past their limit of acceptable change	**CBA 1 (or T1)** areas have **NOT** been identified in the project area (figure 2.6)
CBA 2 (T2 on figure 2.6)	• These are classified as ***Near-Natural Landscapes*** with largely intact and undisturbed ecosystems and species • These areas have an intermediate irreplaceability or some flexibility in terms of area required to meet biodiversity targets i.e. there is some flexibility for the loss of some biodiversity in these landscapes without compromising meeting the biodiversity targets • These landscape are approaching but have not passed their limits of acceptable change	The following infrastructure occurs within the CBA 2 area: • Haul Road 1 and Haul road 2 options • The Tailrace Laydown Area • Tailrace tunnel and outfall • The weir • The offtake structure • The 132kV overhead line to Blouputs-Renosterkop The botanical survey found the areas this infrastructure occurs in to generally be intact and in a natural state
Ecological Support Areas (ESA) (figure 2.6)	• These are ***Functional Landscapes*** with ecosystems that are moderately to significantly disturbed but still maintain basic functionality • These areas have a low irreplaceability with regard to biodiversity pattern targets as individual species are severely disturbed or reduced in these areas	The majority of the project infrastructure occurs within an ESA

2.2.5 National Protected Areas Expansion Strategy (NPAES)

A National Spatial Biodiversity Assessment was conducted in 2004, revealing a lack of protection for a representative sample of the country's biodiversity, and shortcomings in conserving adequate ecological process areas. The Protected Areas Expansion Strategy allows for increased conservation of these areas of the country in order to meet national biodiversity targets. The strategy outlines two methods of expanding the current National Protected Areas:

- For public land, the declaration of available, under-utilised and strategic parcels of public land in concordance with the relevant legal requirements for disposal of such land;
- For private land, contractual agreements with the affected landowners.

An area is considered important for expansion if it contributes to meeting biodiversity thresholds, maintaining ecological processes or climate change resilience. Forty-two focus areas for land-based protected area expansion have been identified and are composed of large, intact and

fragmented areas suitable for the creation or expansion of large protected areas. The study area falls within the Kamiesberg Bushmanland Augrabies NPAES. Section 2.6 provides an explanation as to why this area should fall within an NPAES and not a protected area in accordance with the available spatial planning tools.

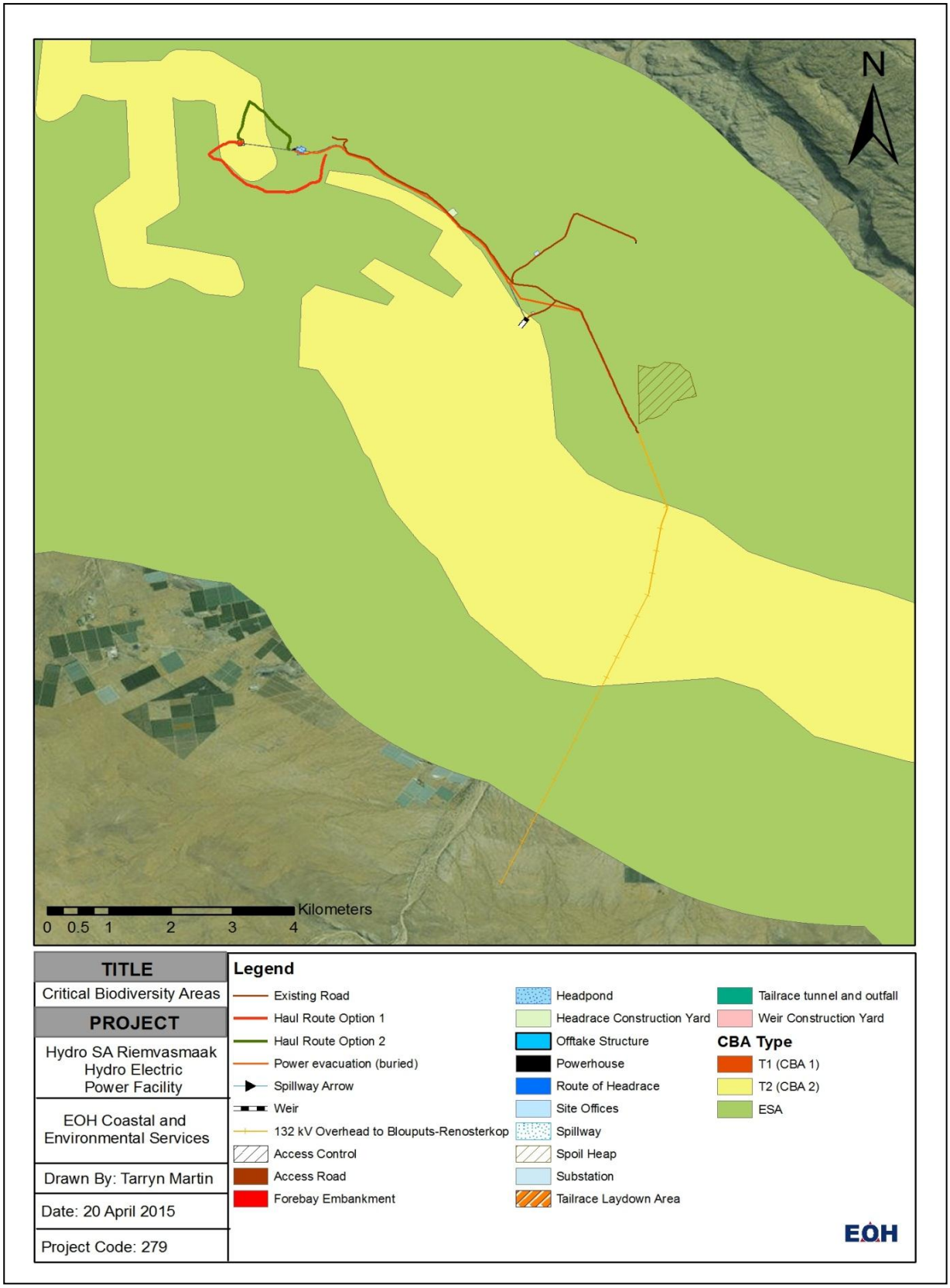


Figure 2.6: Map illustrating the spatial distribution of the Critical Biodiversity Areas (CBA) affected by the project infrastructure

2.2.6 National List of Ecosystems that are threatened and in need of protection (NEMBA, Act 10 of 2004)

The National Environmental Management: Biodiversity Act (NEMBA, Act 10 of 2004) provides a list of threatened terrestrial ecosystems, published in GN 1002 on 9th December 2011. This was established because little attention has historically been paid to the protection of ecosystems outside of protected areas. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition to these areas.

The threatened ecosystem shown below (Figure 2.7) - Lower Gariep Alluvial Vegetation (Ref AZA3) - falls within the area delineated as a CBA 2 area by the Namakwa District Biodiversity Sector Plan (2008). For the most part, project infrastructure is located outside of these areas, but the diversion weir and offtake structure will affect a small area of riparian vegetation on the north bank of the river, and the 132 kV overhead line to Blouputs-Renosterveld crosses also over this area (Figure 2.7). However, given the small footprint associated with a powerline, and the fact that much of the land is given over to agriculture, the impacts on this ecosystem are likely to be minimal if mitigation measures are properly implemented.

2.3 Fauna

2.3.1 Reptiles

Reptile diversity is generally highest in the north eastern extremes of South Africa and declines to the south and west (Alexander and Marais, 2010). However, there are localized patches that are high in species richness. The Northern Cape is one of these regions with relatively high species richness and a high proportion of endemics. Most species in this region are confined to rocky habitats and several species are threatened.

According to the Reptile Atlas of Southern Africa (2015), historical records for the Quarter Degree Square (QDS) (2820 CB) and habitat distribution maps indicate that 43 reptile species were found to occur in the region; of these the majority were listed as Least Concern species. Only *Varanus niloticus* (Water Monitor) was listed on CITES as Appendix II species and *Psammobates oculifer* (Serrated Tent Tortoise) *and Stigmochelys pardalis* (Leopard Tortoise) were listed as Schedule 2 species on the Provincial Nature Conservation Ordinance (PNCO).

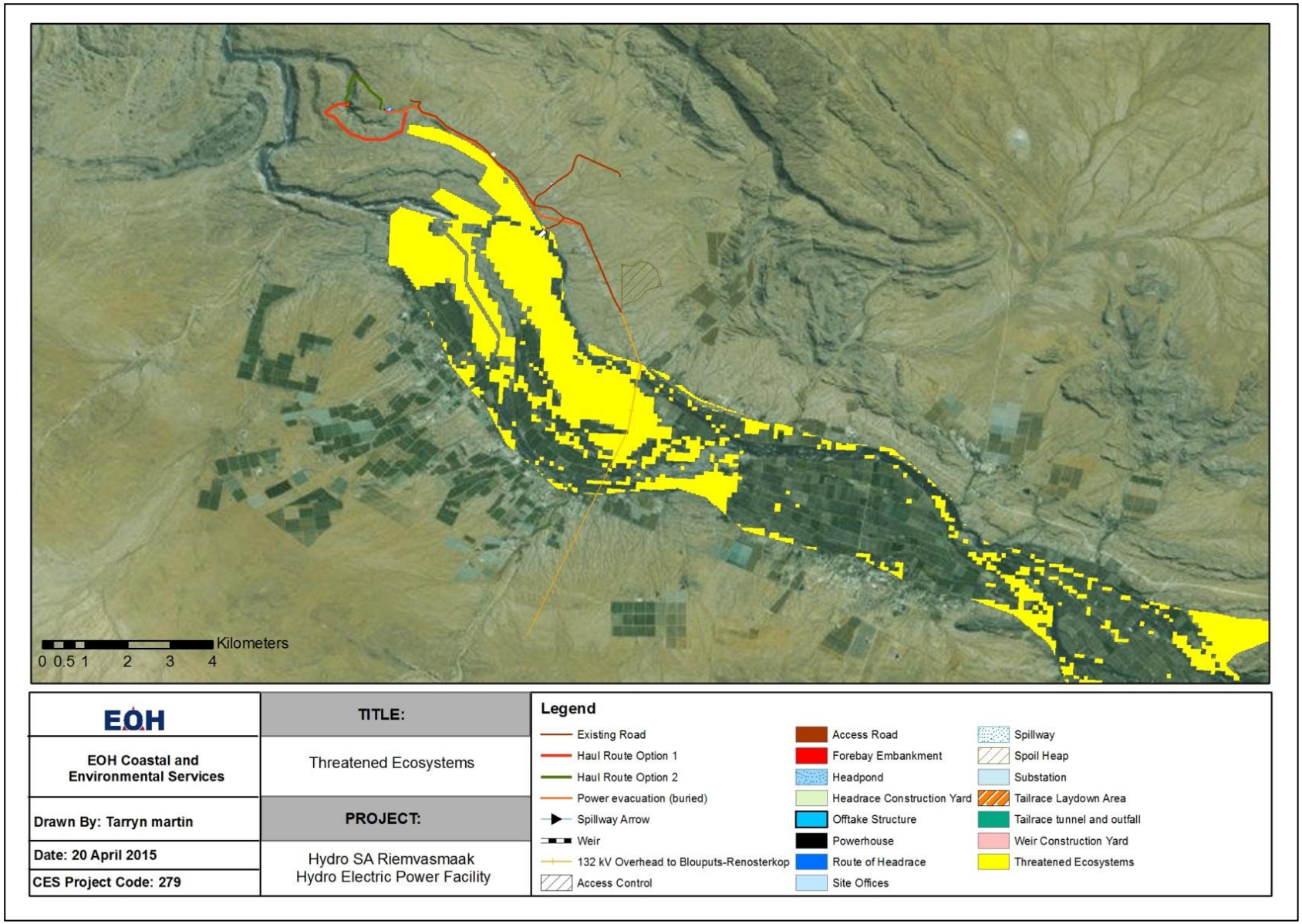


Figure 2.7: Map illustrating the spatial distribution of the threatened ecosystems affected by the project infrastructure

Table 2.2: Reptile species that may occur in the project area according to the Reptile Atlas of Southern Africa

Family	Scientific Name	Common Name	IUCN	CITES	PNCO
Agamidae	*Agama aculeata aculeata*	Common Ground Agama	Least Concern	-	-
Agamidae	*Agama anchietae*	Anchieta's Agama	Least Concern	-	-
Agamidae	*Agama atra*	Southern Rock Agama	Least Concern	-	-
Agamidae	*Agama knobeli*	Knobel's Rock Agama	-	-	-
Amphisbaenidae	*Monopeltis infuscata*	Dusky Worm Lizard	Least Concern	-	-
Amphisbaenidae	*Zygaspis quadrifrons*	Kalahari Dwarf Worm Lizard	Least Concern	-	-
Atractaspididae	*Xenocalamus bicolor bicolor*	Bicoloured Quill-snouted Snake	Least Concern	-	-
Colubridae	*Boaedon capensis*	Brown House Snake	Least Concern	-	-
Colubridae	*Dasypeltis scabra*	Rhombic Egg-eater	Least Concern	-	-
Colubridae	*Dipsina multimaculata*	Dwarf Beaked Snake	Least Concern	-	-
Colubridae	*Lycophidion capense capense*	Cape Wolf Snake	Least Concern	-	-
Colubridae	*Prosymna frontalis*	Southwestern Shovel-snout	Least Concern	-	-
Colubridae	*Psammophis notostictus*	Karoo Sand Snake	Least Concern	-	-
Colubridae	*Telescopus semiannulatus polystictus*	Damara Tiger Snake	Least Concern	-	-
Cordylidae	*Karusasaurus polyzonus*	Karoo Girdled Lizard	Least Concern	-	-
Cordylidae	*Platysaurus broadleyi*	Augrabies Flat Lizard	Least Concern	-	-
Elapidae	*Naja nigricincta woodi*	Black Spitting Cobra	Least Concern	-	-
Elapidae	*Naja nivea*	Cape Cobra	Least Concern	-	-
Gekkonidae	*Chondrodactylus angulifer angulifer*	Common Giant Ground Gecko	Least Concern	-	-
Gekkonidae	*Chondrodactylus bibronii*	Bibron's Gecko	Least Concern	-	-
Gekkonidae	*Chondrodactylus turneri*	Turner's Gecko	Least Concern	-	-
Gekkonidae	*Pachydactylus atorquatus*	Augrabies Gecko	Least Concern	-	-
Gekkonidae	*Pachydactylus haackei*	Haacke's Gecko	Least Concern	-	-
Gekkonidae	*Pachydactylus latirostris*	Quartz Gecko	Least Concern	-	-
Gekkonidae	*Pachydactylus montanus*	Namaqua Mountain Gecko	Least Concern	-	-
Gekkonidae	*Pachydactylus purcelli*	Purcell's Gecko	Least Concern	-	-
Gekkonidae	*Ptenopus garrulus maculatus*	Spotted Barking Gecko	Least Concern	-	-
Gerrhosauridae	*Cordylosaurus subtessellatus*	Dwarf Plated Lizard	Least Concern	-	-
Lacertidae	*Pedioplanis inornata*	Plain Sand Lizard	Least Concern	-	-

Family	Scientific Name	Common Name	IUCN	CITES	PNCO
Lacertidae	*Pedioplanis namaquensis*	Namaqua Sand Lizard	Least Concern	-	-
Leptotyphlopidae	*Namibiana occidentalis*	Western Thread Snake	Least Concern	-	-
Scincidae	*Acontias lineatus*	Striped Dwarf Legless Skink	Least Concern	-	-
Scincidae	*Trachylepis occidentalis*	Western Three-striped Skink	Least Concern	-	-
Scincidae	*Trachylepis sparsa*	Karasburg Tree Skink	Least Concern	-	-
Scincidae	*Trachylepis spilogaster*	Kalahari Tree Skink	Least Concern	-	-
Scincidae	*Trachylepis sulcata sulcata*	Western Rock Skink	Least Concern	-	-
Scincidae	*Trachylepis variegata*	Variegated Skink	Least Concern	-	-
Testudinidae	*Psammobates oculifer*	Serrated Tent Tortoise	Least Concern	-	Schedule 2
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	Least Concern	-	Schedule 2
Typhlopidae	*Rhinotyphlops schinzi*	Schinz's Beaked Blind Snake	Least Concern	-	-
Varanidae	*Varanus niloticus*	Water Monitor	Least Concern	App. II	-
Viperidae	*Bitis arietans arietans*	Puff Adder	Least Concern	-	-

Sixteen reptile species were recorded during the faunal survey, with a further three species collected earlier at Farm Dabaras. Thirty seven other species have been recorded from the general region. Two geckos, previously unrecorded in the AFNP reptile checklist, were shown to be present during the faunal survey. The Augrabies Thick-toed Gecko (*Pachydactylus atorquatus*) was only recently described from specimens collected in the AFNP. It was recorded in the Riemvasmaak area, only the second record of the species north of the Orange River. Haacke's Thick-toed Gecko occurs mainly in southern Namibia with small populations known from the lower Orange River, particularly in the Richtersveld and Augrabies region. It was common on the rock faces of the AFNP 'Canyon Zone', on both sides of the river.

There are no threatened reptile species recorded from the project area or immediate adjacent areas. Two monitor lizards and two chelonians are listed on CITES Appendix II, but all are common throughout much of the region and are well protected in existing conserved areas.

2.3.2 Amphibians

Amphibians are well represented in sub-Saharan Africa, from which approximately 600 species have been recorded. However, amphibian distribution in southern Africa is uneven both in terms of species distribution and in population numbers (du Preez and Carruthers, 2009). Climate, centres of origin and range restrictions are the three main factors that determine species distribution with the eastern coast of South Africa having the highest species diversity and endemicity. In contrast, the Northern Cape has a low amphibian endemicity and diversity.

According to the Reptile Atlas of Southern Africa (2015), historical records for the Quarter Degree Square (QDS) (2820 CB) and habitat distribution maps indicate that 7 species may occur in the project area, provided there are suitable micro-habitats to support them. All these species are listed as Least Concern on the IUCN Red List of Threatened Species, all were listed as Schedule 2 on the PNCO, and none of the species were listed on NEMBA and CITES.

Table 2.3: Amphibian species that may occur in the project area according to the Reptile Atlas of Southern Africa

Family	Scientific Name	Common Name	IUCN	NEMBA	CITES	PNCO
Bufonidae	*Vandijkophrynus gariepensis*	Karoo Toad	Least Concern	-	-	Schedule 2
Bufonidae	*Amietophrynus gutturalis*	African Common Toad (Guttural Toad)	Least Concern	-	-	Schedule 2
Bufonidae	*Amietophrynus poweri*	-	Least Concern	-	-	Schedule 2
Bufonidae	*Amietophrynus rangeri*	Ranger's Toad (Raucous Toad)	Least Concern	-	-	Schedule 2
Microhylidae	*Phrynomantis annectens*	Marbled Rubber Frog	Least Concern	-	-	Schedule 2
Ranidae	*Afrana angolensis*	Common River Frog	Least Concern	-	-	Schedule 2
Ranidae	*Tomopterna cryptotis*	Common Sand Frog	Least Concern	-	-	Schedule 2

Only three of these amphibian species were recorded in the project area during the survey visit; the Guttural Toad, Marbled Rubber Frog, and tadpoles of Poynton's River Frog. The Guttural Toad has an extensive range in the savannahs of southern and eastern Africa, and is tolerant of human development. It has expanded its range, in association with irrigated agriculture, along the Lower Orange River.

No threatened amphibian species or Species of Conservation Concern (SCC) occur in the project area. The Marbled Rubber Frog is listed as 'endemic' for AFNP, but although nationally restricted to rocky habitats along the Lower Orange River, it extends through western Namibia to southern Angola, and globally and nationally is of Least Concern.

2.3.3 Birds

Historical data obtained from the South African National Biodiversity Institute (SANBI) show that 138 bird species have been recorded within the QDS (2820 CB) in which the project area is situated. Of the 138 species, 3 species namely *Circus maurus* (Black Harrier), *Neotis Ludwigii* (Ludwig's Bustard) and *Polemaetus bellicosus* (Martial Eagle) were listed under the IUCN. Four species were listed as Vulnerable according to NEM:BA, these were *Ciconia nigra* (Black stork)*, Falco peregrinus* (Peregrine Falcon), *Neotis Ludwigii* (Ludwig's Bustard) and *Polemaetus bellicosus* (Martial Eagle). 131 species were listed as Schedule 2 species according to PNCO.

Table 2.4: Bird species recorded within the QDS

Family	Scientific Name	Common names (Eng)	Red List status	NEMBA	PNCO
SYLVIIDAE	*Acrocephalus gracilirostris*	Lesser Swamp-warbler, Lesser Swamp Warbler, Lesser Swamp-Warbler	LC	-	Schedule 2
SCOLOPACIDAE	*Actitis hypoleucos*	Common Sandpiper	LC	-	Schedule 2
JACANIDAE	*Actophilornis africanus*	African Jacana	LC	-	Schedule 2
PSITTACIDAE	*Agapornis roseicollis*	Rosy-faced Lovebird	LC	-	Schedule 2
ANATIDAE	*Alopochen aegyptiaca*	Egyptian Goose	LC	-	Schedule 2
ESTRILDIDAE	*Amadina erythrocephala*	Red-headed Finch	LC	-	Schedule 2
ANATIDAE	*Anas capensis*	Cape Teal	LC	-	Schedule 2
ANATIDAE	*Anas erythrorhyncha*	Red-billed Duck, Red-billed Teal	LC	-	Schedule 2
ANATIDAE	*Anas sparsa*	African Black Duck	LC	-	Schedule 2

Family	Scientific Name	Common names (Eng)	Red List status	NEMBA	PNCO
ANATIDAE	*Anas undulata*	Yellow-billed Duck	LC	-	Schedule 2
ANHINGIDAE	*Anhinga rufa*	African Darter, Darter	LC	-	Schedule 2
REMIZIDAE	*Anthoscopus minutus*	Cape Penduline Tit, Southern Penduline-tit, Southern Penduline-Tit	LC	-	Schedule 2
APODIDAE	*Apus affinis*	House Swift, Little Swift	LC	-	Schedule 2
APODIDAE	*Apus apus*	Common Swift, European Swift, Swift	LC	-	Schedule 2
APODIDAE	*Apus bradfieldi*	Bradfield's Swift	LC	-	Schedule 2
APODIDAE	*Apus caffer*	African White-rumped Swift, White-rumped Swift	LC	-	Schedule 2
ACCIPITRIDAE	*Aquila verreauxii*	Black Eagle, Verreaux's Eagle	LC	-	Schedule 2
ARDEIDAE	*Ardea cinerea*	Gray Heron, Grey Heron	LC	-	Schedule 2
ARDEIDAE	*Ardea goliath*	Goliath Heron	LC	-	Schedule 2
ARDEIDAE	*Ardea melanocephala*	Black-headed Heron	LC	-	Schedule 2
ARDEIDAE	*Ardea purpurea*	Purple Heron	LC	-	Schedule 2
MUSCICAPIDAE	*Bradornis infuscatus*	Chat Flycatcher	LC	-	Schedule 2
STRIGIDAE	*Bubo africanus*	Spotted Eagle-owl, Spotted Eagle Owl, Spotted Eagle-Owl	LC	-	Schedule 2
ARDEIDAE	*Bubulcus ibis*	Cattle Egret	LC	-	Schedule 2
BURHINIDAE	*Burhinus capensis*	Spotted Dikkop, Spotted Thick-knee	LC	-	Schedule 2
ACCIPITRIDAE	*Buteo rufofuscus*	Jackal Buzzard	LC	-	Schedule 2
ALAUDIDAE	*Calandrella cinerea*	Red-capped Lark	LC	-	Schedule 2
SCOLOPACIDAE	*Calidris ferruginea*	Curlew Sandpiper	LC	-	Schedule 2
SCOLOPACIDAE	*Calidris minuta*	Little Stint	LC	-	Schedule 2
PICIDAE	*Campethera abingoni*	Golden-tailed Woodpecker	LC	-	Schedule 2
CAPRIMULGIDAE	*Caprimulgus rufigena*	Rufous-cheeked Nightjar	LC	-	Schedule 2
CAPRIMULGIDAE	*Caprimulgus tristigma*	Freckled Nightjar, Freckled Rock Nightjar	LC	-	Schedule 2
MUSCICAPIDAE	*Cercomela familiaris*	Familiar Chat	LC	-	Schedule 2
ALAUDIDAE	*Certhilauda curvirostris*	Cape Long-billed Lark, Long-billed Lark	LC	-	Schedule 2
CHARADRIIDAE	*Charadrius pecuarius*	Kittlitz's Plover	LC	-	Schedule 2
CHARADRIIDAE	*Charadrius tricollaris*	Three-banded Plover	LC	-	Schedule 2
ALAUDIDAE	*Chersomanes albofasciata*	Spike-heeled Lark	LC	-	Schedule 2
CUCULIDAE	*Chrysococcyx caprius*	Dideric Cuckoo, Didric Cuckoo, Diederik Cuckoo	LC	-	Schedule 2
CICONIIDAE	*Ciconia abdimii*	Abdim's Stork	LC	-	Schedule 2
CICONIIDAE	*Ciconia nigra*	Black Stork	LC	Vulnerable	Schedule 2
ACCIPITRIDAE	*Circaetus pectoralis*	Black-chested Snake-eagle, Black-chested Snake Eagle, Black-chested Snake-Eagle	LC	-	Schedule 2
ACCIPITRIDAE	*Circus maurus*	Black Harrier	VU	-	Schedule 2
COLIIDAE	*Colius colius*	White-backed Mousebird	LC	-	-
COLUMBIDAE	*Columba guinea*	Speckled Pigeon	LC	-	Schedule 2
COLUMBIDAE	*Columba livia*	Common Pigeon, Rock Dove, Rock Dovel, Rock Pigeon	LC	-	Schedule 2
CORACIIDAE	*Coracias caudatus*	Lilac-breasted Roller	LC	-	Schedule 2

Family	Scientific Name	Common names (Eng)	Red List status	NEMBA	PNCO
CORVIDAE	*Corvus albus*	Pied Crow	LC	-	-
CORVIDAE	*Corvus capensis*	Black Crow, Cape Crow	LC	-	-
MUSCICAPIDAE	*Cossypha caffra*	Cape Robin, Cape Robin-chat, Cape Robin-Chat	LC	-	Schedule 2
STURNIDAE	*Creatophora cinerea*	Wattled Starling	LC	-	Schedule 2
GLAREOLIDAE	*Cursorius rufus*	Burchell's Courser	LC	-	Schedule 2
APODIDAE	*Cypsiurus parvus*	African Palm-swift, African Palm Swift, African Palm-Swift, Palm Swift	LC	-	Schedule 2
COLUBRIDAE	*Dasypeltis scabra*	Common Egg Eater, Egg-eating Snake, Rhombic Egg Eater	LC	-	Schedule 2
PICIDAE	*Dendropicos fuscescens*	Cardinal Woodpecker	LC	-	Schedule 2
DICRURIDAE	*Dicrurus adsimilis*	Fork-tailed Drongo	LC	-	Schedule 2
ARDEIDAE	*Egretta garzetta*	Little Egret	LC	-	Schedule 2
ACCIPITRIDAE	*Elanus caeruleus*	Black-shouldered Kite, Black-winged Kite	LC	-	Schedule 2
SYLVIIDAE	*Eremomela icteropygialis*	Yellow-bellied Eremomela	LC	-	Schedule 2
ALAUDIDAE	*Eremopterix verticalis*	Grey-backed Sparrow-lark, Grey-backed Sparrow-Lark	LC	-	Schedule 2
ESTRILDIDAE	*Estrilda astrild*	Common Waxbill	LC	-	Schedule 2
PLOCEIDAE	*Euplectes orix*	Red Bishop, Southern Red Bishop	LC	-	-
OTIDIDAE	*Eupodotis afra*	Black Bustard	LC	-	Schedule 2
FALCONIDAE	*Falco biarmicus*	Lanner, Lanner Falcon	LC	-	Schedule 2
FALCONIDAE	*Falco chicquera*	Red-headed Falcon, Red-headed Merlin, Red-necked Falcon	LC	-	Schedule 2
FALCONIDAE	*Falco peregrinus*	Peregrine, Peregrine Falcon	LC	Vulnerable	Schedule 2
FALCONIDAE	*Falco rupicoloides*	Greater Kestrel	LC	-	Schedule 2
RALLIDAE	*Fulica cristata*	Crested Coot, Red-knobbed Coot, Red-Knobbed Coot	LC	-	Schedule 2
RALLIDAE	*Gallinula chloropus*	Common Moorhen, Moorhen	LC	-	Schedule 2
ACCIPITRIDAE	*Haliaeetus vocifer*	African Fish-eagle, African Fish Eagle, African Fish-Eagle	LC	-	Schedule 2
HIRUNDINIDAE	*Hirundo albigularis*	White-throated Swallow	LC	-	Schedule 2
HIRUNDINIDAE	*Hirundo cucullata*	Greater Striped-swallow, Greater Striped Swallow, Greater Striped-Swallow	LC	-	Schedule 2
HIRUNDINIDAE	*Hirundo dimidiata*	Pearl-breasted Swallow	LC	-	Schedule 2
HIRUNDINIDAE	*Hirundo fuligula*	African Rock Martin, Rock Martin	LC	-	Schedule 2
HIRUNDINIDAE	*Hirundo rustica*	Barn Swallow, European Swallow, Swallow	LC	-	Schedule 2
INDICATORIDAE	*Indicator minor*	Lesser Honeyguide	LC	-	Schedule 2
COENAGRIONIDAE	*Ischnura senegalensis*	Common Bluetail, Marsh Bluetail	LC	-	Schedule 2
ARDEIDAE	*Ixobrychus minutus*	Little Bittern	LC	-	Schedule 2
NYMPHALIDAE	*Junonia hierta*	Yellow Pansy	LC	-	Schedule 2
CYPRINIDAE	*Labeobarbus aeneus*	Vaal-orange Smallmouth Yellowfish	LC	-	Schedule 2
STURNIDAE	*Lamprotornis nitens*	Cape Glossy Starling, Cape Starling, Red-	LC	-	Schedule 2

Family	Scientific Name	Common names (Eng)	Red List status	NEMBA	PNCO
		shouldered Glossy-starling, Red-shouldered Glossy-Starling			
MALACONOTIDAE	*Laniarius atrococcineus*	Crimson-breasted Gonolek, Crimson-breasted Shrike	LC	-	Schedule 2
LANIIDAE	*Lanius collaris*	Common Fiscal	LC	-	Schedule 2
LANIIDAE	*Lanius collurio*	Red-backed Shrike	LC	-	Schedule 2
LANIIDAE	*Lanius minor*	Lesser Grey Shrike	LC	-	Schedule 2
CICONIIDAE	*Leptoptilos crumeniferus*	Marabou, Marabou Stork	LC	-	Schedule 2
ACCIPITRIDAE	*Melierax canorus*	Pale Chanting-goshawk, Pale Chanting Goshawk, Pale Chanting-Goshawk	LC	-	Schedule 2
MEROPIDAE	*Merops apiaster*	Bee-eater, European Bee-eater	LC	-	Schedule 2
MEROPIDAE	*Merops hirundineus*	Swallow-tailed Bee-eater	LC	-	Schedule 2
ACCIPITRIDAE	*Milvus migrans*	Black Kite	LC	-	Schedule 2
ACCIPITRIDAE	*Milvus migrans*	Black Kite	LC	-	Schedule 2
MOTACILLIDAE	*Motacilla aguimp*	African Pied Wagtail, African Wagtail	LC	-	Schedule 2
MOTACILLIDAE	*Motacilla capensis*	Cape Wagtail	LC	-	Schedule 2
MUSCICAPIDAE	*Muscicapa striata*	Spotted Flycatcher	LC	-	Schedule 2
OTIDIDAE	*Neotis ludwigii*	Ludwig's Bustard	EN	Vulnerable	Schedule 2
MALACONOTIDAE	*Nilaus afer*	Brubru	LC	-	Schedule 2
SCOLOPACIDAE	*Numenius phaeopus*	Whimbrel	LC	-	Schedule 2
NUMIDIDAE	*Numida meleagris*	Helmeted Guineafowl, Tufted Guineafowl	LC	-	Schedule 2
COLUMBIDAE	*Oena capensis*	Namaqua Dove	LC	-	Schedule 2
STURNIDAE	*Onychognathus nabouroup*	Pale-winged Starling	LC	-	Schedule 2
ORIOLIDAE	*Oriolus oriolus*	Eurasian Golden Oriole, Eurasian Golden-Oriole, European Golden Oriole, Golden Oriole	LC	-	Schedule 2
PARIDAE	*Parus cinerascens*	Ashy Tit	LC	-	Schedule 2
PASSERIDAE	*Passer diffusus*	Cape Sparrow, Southern Grey-headed Sparrow	LC	-	Schedule 2
PASSERIDAE	*Passer melanurus*	Cape Sparrow, Mossie	LC	-	Schedule 2
PHALACROCORACIDAE	*Phalacrocorax africanus*	Long-tailed Cormorant, Reed Cormorant	LC	-	Schedule 2
SYLVIIDAE	*Phylloscopus trochilus*	Willow Warbler	LC	-	Schedule 2
ANATIDAE	*Plectropterus gambensis*	Spur-winged Goose	LC	-	Schedule 2
PLOCEIDAE	*Ploceus capensis*	Cape Weaver	LC	-	Schedule 2
PLOCEIDAE	*Ploceus velatus*	African Masked Weaver, Southern Masked-weaver, Southern Masked Weaver, Southern Masked-Weaver	LC	-	Schedule 2
ACCIPITRIDAE	*Polemaetus bellicosus*	Martial Eagle	VU	Vulnerable	Schedule 2
FALCONIDAE	*Polihierax semitorquatus*	Pygmy Falcon	LC	-	Schedule 2
ACCIPITRIDAE	*Polyboroides typus*	African Harrier-hawk, African Harrier-Hawk, Gymnogene	LC	-	Schedule 2

Family	Scientific Name	Common names (Eng)	Red List status	NEMBA	PNCO
RALLIDAE	*Porzana pusilla*	Baillon's Crake, Marsh Crake	LC	-	Schedule 2
PTEROCLIDIDAE	*Pterocles namaqua*	Namaqua Sandgrouse	LC	-	Schedule 2
PYCNONOTIDAE	*Pycnonotus nigricans*	African Red-eyed Bulbul, Black-fronted Bulbul, Red-eyed Bulbul	LC	-	-
PLOCEIDAE	*Quelea quelea*	Red-billed Quelea	LC	-	-
PHOENICULIDAE	*Rhinopomastus cyanomelas*	Common Scimitarbill, Common Scimitar-bill, Scimitarbill	LC	-	Schedule 2
HIRUNDINIDAE	*Riparia paludicola*	African Sand Martin, Brown-throated Martin, Brown-throated Sand Martin, Plain Martin	LC	-	Schedule 2
SCOPIDAE	*Scopus umbretta*	Hamerkop	LC	-	Schedule 2
FRINGILLIDAE	*Serinus alario*	Black-headed Canary	LC	-	Schedule 2
MUSCICAPIDAE	*Sigelus silens*	Fiscal Flycatcher	LC	-	Schedule 2
MUSCICAPIDAE	*Stenostira scita*	Fairy Flycatcher, Fairy Warbler	LC	-	Schedule 2
COLUMBIDAE	*Streptopelia capicola*	Cape Turtle Dove, Ring-necked Dove	LC	-	Schedule 2
COLUMBIDAE	*Streptopelia semitorquata*	Red-eyed Dove	LC	-	Schedule 2
STRUTHIONIDAE	*Struthio camelus*	Common Ostrich, Ostrich	LC	-	Schedule 2
SYLVIIDAE	*Sylvietta rufescens*	Cape Crombec, Long-billed Crombec	LC	-	Schedule 2
PODICIPEDIDAE	*Tachybaptus ruficollis*	Little Grebe	LC	-	Schedule 2
APODIDAE	*Tachymarptis melba*	Alpine Swift	LC	-	Schedule 2
ANATIDAE	*Tadorna cana*	South African Shelduck	LC	-	Schedule 2
MALACONOTIDAE	*Telophorus zeylonus*	Bokmakierie, Bokmakierie Bushshrike, Bokmakierie Bush-shrike	LC	-	Schedule 2
SCOLOPACIDAE	*Tringa glareola*	Wood Sandpiper	LC	-	Schedule 2
SCOLOPACIDAE	*Tringa nebularia*	Common Greenshank, Greenshank	LC	-	Schedule 2
TURDIDAE	*Turdus olivaceus*	Olive Thrush	LC	-	Schedule 2
COLIIDAE	*Urocolius indicus*	Red-faced Mousebird	LC	-	-
CHARADRIIDAE	*Vanellus armatus*	Blacksmith Lapwing, Blacksmith Plover	LC	-	Schedule 2
CHARADRIIDAE	*Vanellus coronatus*	Crowned Lapwing, Crowned Plover	LC	-	Schedule 2
VIDUIDAE	*Vidua macroura*	Pin-tailed Whydah, Pin-tailed Widow	LC	-	Schedule 2
ZOSTEROPIDAE	*Zosterops pallidus*	Cape White-eye, Pale White-eye	LC	-	Schedule 2

The Nama-Karoo supports a particularly high diversity of bird species endemic to southern Africa, particularly ground-dwelling species of open habitats. Many endemic and near-endemic larks have ranges centred in the Karoo region. The 'linear oasis' of the Lower Orange River supports a greater diversity than more easterly regions of the river valley and the surrounding Nama Karoo. The project area falls within an Important Bird Area (IBA), considered important in the conservation of threatened and near-threatened birds, as well as protecting endemic, near-endemic and range-limited species.

Of the possible 431 bird species which occur in the Northern Cape province of South Africa, 247 species may occur in or near the project area. Of these 247 species, 111 were observed during the faunal survey. Some are non-breeding Palaearctic migrants, whilst others are breeding Intra-

African migrants or species that show seasonal movements within the subcontinent and adjacent Africa. A significant number (13) are Range- or Biome-restricted, or Near Endemic species.

The project area may host 33 species of conservation concern, 14 of which were recorded on site. Twenty one (21) of these SCC are globally threatened (5 Endangered species, 7 Vulnerable species, 9 Near Threatened). Twenty-eight of these also occur in SA Red Data Book – Birds (1 Endangered, 9 Vulnerable and 18 Near Threatened).

Three bird species (Southern Black Korhaan, Cape Long-billed Lark and Cape Bulbul) are endemic South African species, all of which were recorded during the site visit.

The most significant avian SCC that have previously been recorded in the region include the Globally Threatened White-backed Vulture (EN at the time the specialist report was written, but subsequently (April 2015) up-listed to CR), Ludwig's Bustard (EN), Secretary Bird (VU), Black Harrier (VU), and Martial Eagle (VU), as well as the Nationally Threatened Kori Bustard (Vulnerable). These are all wide-ranging species whose population declines result from numerous and wide-spread anthropogenic threats. The presence of 10 nationally Near Threatened birds and no less than 14 Near Endemic or Range- or Biome-Restricted species has increased the significance of the site for the conservation of birds.

2.3.4 Mammals

Large game makes up less than 15% of the mammal species in South Africa and a much smaller percentage in numbers and biomass. In developed and farming areas this percentage is greatly reduced, with the vast majority of mammals present being small or medium-sized. The conservation status of South African mammals has recently been re-assessed and a number of species have been downgraded, for example, the African Wild Cat, Aardvark, Blue Duiker, and Honey Badger are no longer considered threatened.

The Animal Demography Unit historical records indicate that 43 species have been recorded within the QDS (2820 CB).

Species of special concern which may occur in the project area due to their distribution range (Stuart and Stuart, 2007) include *Felis nigripes* and *Manis temminckii* which are listed as Vulnerable and *Parahyaena brunnea* which is listed as Near Threatened on the IUCN red data list. According to NEMBA, 7 protected mammal species and 1 vulnerable mammal species have distributions that coincide with the project area. Based on habitat availability it is likely that some of these species do occur on site (Stuart and Stuart, 2007).

Table 2.5: Threatened mammal species which have distribution ranges which fall within the project area (Stuart and Stuart, 2007)

Common Name	Scientific Name	IUCN	NEMBA
Klipspringer	*Oreotragus oreotragus*	Least Concern	Protected species
Aardvark	*Orycteropus afer*	Least Concern	Protected species
Small spotted cat	*Felis nigripes*	Vulnerable	-
Brown hyaena	*Parahyaena brunnea*	Near Threatened	Protected species
Honey Badger	*Mellivora capensis*	Least Concern	Protected species
Cape fox	*Vulpes chama*	Least Concern	Protected species
Bat-eared fox	*Otocyon megalotis*	Least Concern	Protected species
Gemsbok	*Oryx gazella*	Least Concern	Protected species
Pangolin	*Manis temminckii*	Vulnerable	Vulnerable

Large mammals are not generally a feature in the Nama Karoo, with the majority of mammals

present being small to medium-sized. The long history of persecution and hunting has also reduced large mammal numbers and diversity in the region.

A total of 50 mammal species are listed in the AFNP mammal checklist, but this omits additional bats (five species recorded in the AFNP, a further four recorded in close proximity) and rodents seven species recorded in the AFNP checklist, and a further nine recorded within close proximity). There are also a number of corrections, resulting from new taxonomic insight.

Only 17 terrestrial mammal species were observed during the survey, whilst a further four were identified by scats, etc. Due to time constraints no micro-mammal trapping was undertaken, and this component of the faunal diversity of the project area remains poorly known.

Only one globally threatened mammal, Hartmann's Mountain Zebra (VU) currently occurs in the AFNP. Another, the Hook-lipped Rhinoceros (globally and regionally CR), was previously introduced into the AFNP in the Riemvasmaak region, but has since been re-located. Among the expanded micro-mammal checklist none are globally or nationally threatened, although Shortridge's Thallomys is poorly-known (Data Deficient) and the Dassie Rat and Honey Badger are regionally Near Threatened.

2.4 The Socio-Economic Environment

All details provided in this section are taken from the Socio-economic impact assessment undertaken by ACER for the project (ACER, 2014).

2.4.1 Local communities

Riemvasmaak

Riemvasmaak lies approximately 15 km north-east of the Augrabies Falls National Park. The Riemvasmaak community was forcibly removed from its land in 1973 and 1974 under unjust Apartheid policies and the land was used by the South African Military, among other things, as a missile testing range. The forced removal of the community was particularly brutal. Approximately 1 500 people were divided into three groups. Those who were classified under Apartheid laws as Xhosa were moved to Welcomewood in the Ciskei in 1973. Those who were classified of Nama or Damara heritage were forcibly relocated 1 300 kilometres away to Khorixas in northern Namibia in 1973 and 1974. Lastly, those who were classified as coloured remained in areas surrounding Riemvasmaak, such as Marchand, Augrabies and Kiemoes.

Riemvasmaak has a special place in South African history as it was the first land restitution case after the election of a democratic government. In 1994, previous Riemvasmaakers returned to the land from where they had been forcibly removed 21 years earlier.

During discussions with members of the local community, the ward councillor and local government officials, issues such as high unemployment, poor levels of education and few employment opportunities were identified as the major challenges facing the community.

Augrabies

Augrabies is a small town in the Northern Cape province of South Africa, situated on the banks of the Orange River about 100 km downstream from Upington and immediately outside the Augrabies Falls National Park.

The town is surrounded by vineyards and home predominantly to workers in the Orange River wine sector, with the Orange River wine cellars said to be the second largest co-operative wine cellar in the world.

During discussions with various community members from Augrabies, local government officials and ward councillors, a number of challenges facing the community were identified, including high

levels of unemployment and poverty, high level of illiteracy and few opportunities.

Augrabies Falls National Park

The AFNP is located about 120 km west of Upington. It covers an area of 820 km². The waterfall is approximately 56 m high and is awe-inspiring when the river is in flood.

AFNP is the largest conservation area (51 430 ha) within the Orange River Broken Veld vegetation type. Nearly 70 different species of grass, shrubs, herbs and trees can be found in the AFNP, with the most characteristic plant in the park being the giant aloe (quiver tree (kokerboom); *Aloe dichotoma* (http://www.sanparks.co.za)).

The study area itself is located on the northern side of the Orange River. The area is generally in a pristine condition, although old homesteads, tourist accommodation (currently not open to the public) and dirt roads/tracks are found in the area.

2.4.2 Overview of the project area

This section provides insight into the socio-economic conditions currently prevailing in the project area. This enables the proposed project to be placed in context, enabling the identification of potential issues and associated impacts that the project is likely to have on the socio-economic environment as well as the impacts which the socio-economic environment are likely to have on the project.

The study site is located partly on the farm Riemvasmaak (Portion 1 of Farm No. 498), which is owned by the Reimvasmaak community, and partly on farm Waterval (Remainder of Farm No. 497), which is within the boundaries of the AFNP. The site is approximately 32 km north west of the town of Kakamas in the Northern Cape Province of South Africa, and falls entirely within the Kai !Garib Local Municipality (LM). which itself forms part of the ZF Mgcawu District Municipality (DM) (until July 2013 previously known as Siyanda DM) in the Northern Cape Province.

Population

In terms of area, the Northern Cape is the largest province in South Africa (372 889 km^2) accounting for 30.5% of the entire country. Despite accounting for almost a third of the land in South Africa, the Northern Cape has the smallest population of all the provinces, with a total population of 1 145 861 people and is, thus, the least densely populated region, with an average population density of 3.1 people per square kilometre (StatsSA, 2011).

The ZF Mgcawu DM covers an area of 102 524 square kilometres with a population of 236 783 (2.3 people per square kilometre), while the Kai !Garib covers an area of 26 358 square kilometres with a population of 65 869 (2.5 people per square kilometre) (StatsSA, 2011). These figures show that the Kai !Garib municipality is marginally more densely populated than the district but is noticeably less densely populated than the province as a whole. This is likely the result of few urban settlements within the district municipal area.

Other population indicators show similar trends throughout the Northern Cape, ZF Mgcawu DM and Kai !Garib LM. There is, however, a noticeable difference in annual average household incomes, with households in the Kai !Garib LM earning below the provincial and district averages. It should be noted that households in the Northern Cape, ZF Mgcawu DM and the Kai !Garib LM all fall well below the South African average annual household income of R119 542 (StatsSA, 2011). Table 2.6 presents the figures discussed above.

Table 2.6: Population indicators (StatsSA, 2011)

2011	Northern Cape	ZF Mgcawu DM	Kai !Garib LM
Total Population	1 145 861	236 783	65 869
Population Density (people per km²)	3.1	2.3	2.5
Average Population Growth Rate	2.1%	2.1%	2.1%
Total Households	301 367	61 086	16,700
Average Household Size	3.8	3.9	3.9
Female Headed Households	33.8%	35.7%	34.6%
Formal Dwellings	82.4%	79.4%	88.4%
Average Household Income Per Annum	R 86 158.00	R 92 878.00	R 71 739.00

Education

The percentage of the population over the age of 20 within the Kai !Garib reported to never have received any formal education decreased from 14.7% in 2001 to 9% in 2011 thus showing a general improvement in access to education. The percentage of the population within Kai !Garib over the age of 20 with a Grade 12 level of education has also seen improvements between 2001 (11.2%) and 2011 (15.5%); however, these figures are significantly lower than the provincial average (22.7%) and the district average (21.7%). This trend continues with access to tertiary education in the Kai !Garib, again, below the provincial and district averages. Table 2.7 provides details on access to education.

Table 2.7: Education indicators (Stats SA, 2011)

	No School (%)		Grade 12 (%)		Tertiary Education (%)	
	2001	**2011**	**2001**	**2011**	**2001**	**2011**
Kai !Garib	14.7	9	11.2	15.5	3.7	3.9
ZF Mgcawu District	16.5	9.6	15.8	21.7	4.7	6.3
Northern Cape	19.3	11.3	15.8	22.7	5.9	7.5
South Africa	17.9	8.6	20.4	28.9	8.5	11.8

Within Kai !Garib LM, there are 20 pre-primary schools/crèches, 26 primary schools and five secondary/high schools. Of these, three pre-primary schools/crèches, five primary schools and no secondary/high schools are located in the Augrabies and Riemvasmaak areas. These figures are consistent with findings from discussions with the Kai !Garib LED and Tourism Officer, a headmaster from the town of Augrabies and the Ward Councillor, all of whom noted the lack of access to high schools and tertiary education, especially in the towns of Augrabies and Riemvasmaak, as a major challenge facing education and, in turn, to socio-economic development.

Economic sectors

The majority of economic activity within the Kai !Garib LM takes place around the Orange River, with the most towns and settlements found adjacent to the river (Kai !Garib IDP, 2013-2014). The agricultural sector is the main driver of the local economy, contributing 51.8% of the municipal GDP and also accounting for 66.5% of all formal employment (Kai !Garib IDP, 2013-2014). The agricultural sector is heavily dependent on the cultivation of grapes for export and for the production of wine and raisins. There has also been a noticeable growth in citrus production in the area (Kai !Garib IDP, 2013 – 2014).

There are a number of emerging farmers in the municipality who focus predominantly on small stock farming, lucerne, cotton, corn and nut production (with crop production being under irrigation with water sourced from the Orange River). These farmers are constrained by poor quality access roads and a lack of available funding (Kai !Garib IDP, 2013 – 2014).

Other major contributors to the municipal GDP include community and government services (15.9%) and the wholesale and retail sectors (11.3%) (Kai !Garib IDP, 2013–2014). It should be noted that the possibility of the area contributing to the generation of sustainable energy, in particular, solar energy, has been identified as a sector with significant scope for growth and possible spinoff benefits for the local community (Kai !Garib IDP, 2013–2014). Figure 2.8 below illustrates the contributions made by each of the economic sectors.

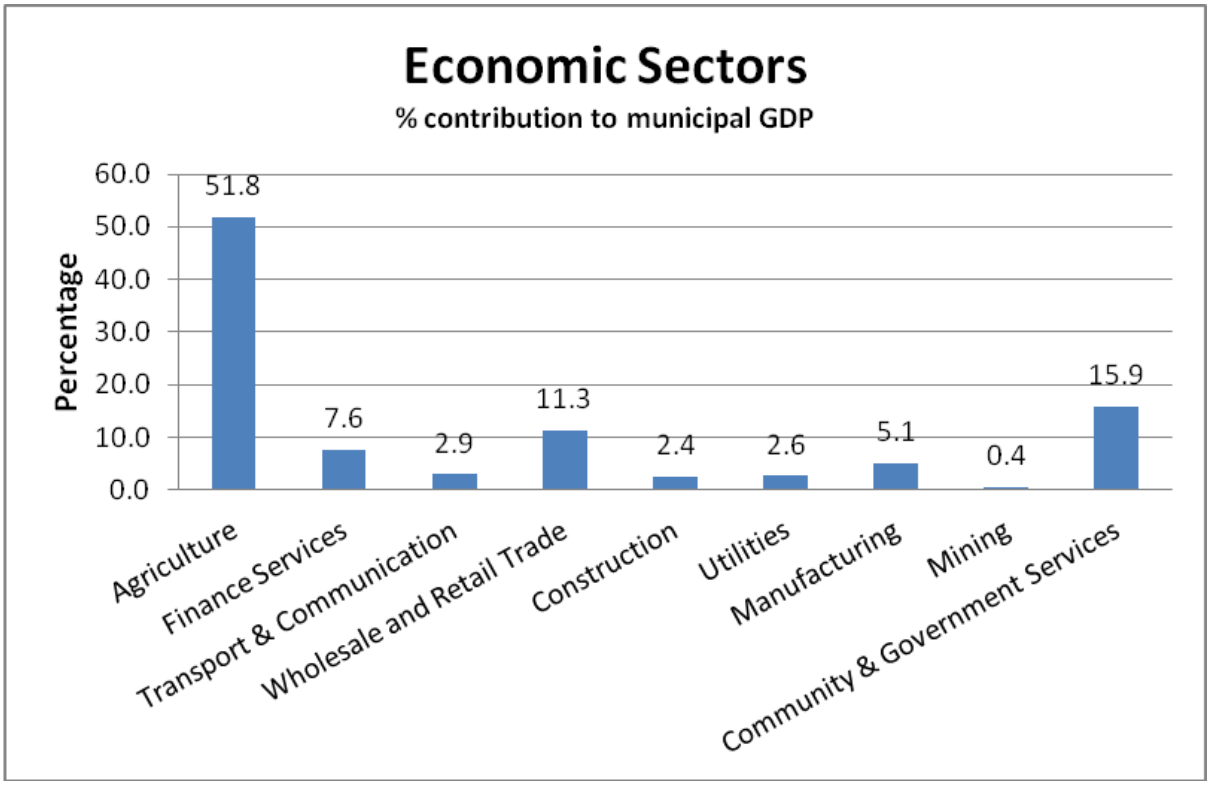


Figure 2.8: Percentage contribution to the Kai !Garib municipal GDP per economic sector (Kai !Garib IDP, 2013-2014)

Sectoral Analysis

Agriculture

The agricultural sector is dominated by fruit, livestock and game farming. The main activity is the production of table grapes but there has been an increase in citrus growing while lucerne, dates and nuts are also grown. There is a paucity of disaggregated production data, the last Agricultural Census having being undertaken in 2007. The reports from this Census are at a provincial level. Among private-sector agricultural bodies, the available statistics are mainly at the provincial level or the Orange River regional level, depending on the source.

The production of grapes has led to the construction of packing stores and cool rooms on major farms as well as in Kakamas. The industry as a whole has transformed the economy of the area since the 1960s.

Manufacturing

The importance of the manufacturing sector might be understated in the Census data, as it appears that agro-industry is included under the agricultural sector rather than under manufacturing.

Tourism

Although new investment continues to be attracted to this sector, the Siyanda IDP pointed out that the volume of tourists was insufficient to act as a driver of the economy. Nonetheless, it was the fastest-growing component of the economy between 2007 and 2011. The Kai!Garib IDP states that there is substantial growth potential in the sector.

Retail and Services
This sector has grown but its potential is limited by the small size of the market. The size of the Kakamas retail and wholesale sector in terms of annual turnover was estimated by a leading enterprise at about R750 million.

Transport and Communications
The growth of irrigated agriculture in the LM has led to the establishment of a substantial local trucking and logistics sector.

Summary
The economy of the Kai!Garib LM is small in relation to the national economy and might be about 17% of the provincial economy. It is dominated by agriculture and agro-industry which have substantial linkages with other sectors such as trade, transport, logistics, construction, utilities and financial services. The agricultural sector is highly dependent on the availability of water from the Orange River. A promising opportunity for economic diversification lies in the field of power generation using the area's endowment of renewable energy sources such as sun, wind and water.

Employment

Unemployment in the Kai !Garib LM is reported to have improved significantly between 2001 and 2011, dropping from 16.1% in 2001 to 10% in 2011 (StatsSA, 2011). In addition, these figures are below both the provincial (28.1%) and district (21%) average for 2011 (StatsSA, 2011). It should, however, be noted that these figures are for the official unemployment rate and may be somewhat misleading, as they exclude those sectors of the population who fall within the economically active sector of the population but are not economically active.

This view is supported by findings during field work where a number of respondents identified high unemployment as a major factor limiting development in the area. In addition, the Kai !Garib LM IDP (2013-2014) notes that the majority of residents are reliant on government pensions and grants, and live in poor conditions. High levels of unemployment among the youth were a further issue identified in the municipal IDP as a significant factor contributing to social ills in the area. Table 2.8 provides a comparison in employment levels between the provincial, district and local spheres for both the working age population and the youth.

Table 2.8: Official unemployment rates (StatsSA, 2001 & 2011)

	Unemployment (Official)		Youth Unemployment (Official)	
	2001	**2011**	**2001**	**2011**
Kai !Garib LM	16.1%	10%	17.7%	10%
ZF Mgcawu DM	26.5%	19.2%	32.1%	22.7%
Northern Cape	35.6%	27.4%	44.1%	34.5%

2.4.3 Access to basic services

Access to piped water

Access to piped water within the Kai !Garib LM is worse than within both the district municipality and province. In the Kai !Garib LM, 7% of households reported no access to piped water, while 4% and 3% reported no access in the ZF Mgcawu DM and the Northern Province, respectively (StatsSA, 2011). It is of interest, however, that a higher proportion of the population within the Kai !Garib LM reported having access to piped water within their dwelling or yard than the provincial average. What is of concern is that there has been very little improvement in access to piped water between 2001 and 2011 within the Kai !Garib LM, with the percentage of the population without access dropping from 9% to 7%. Table 2.9 provides details of changes in the level of access within the local and district municipalities and the province between 2001 and 2011.

Table 2.9: Access to piped water (StatsSA, 2001 & 2011)

	Piped water inside dwelling/yard		Piped water at communal stand		No access to piped water	
	2001	2011	2001	2011	2001	2011
Kai !Garib LM	81.5%	82.9%	9.8%	10.3%	8.7%	6.8%
ZF Mgcawu DM	79.4%	86.2%	15.5%	9.5%	5.1%	4.3%
Northern Cape	71.9%	78.1%	22.0%	19.3%	6.1%	2.6%

Access to sanitation

Access to sanitation within the Kai !Garib LM is worse than the overall levels experienced by households within the ZF Mgcawu DM and the Northern Cape Province. In 2011, 12% of households within Kai !Garib LM reported no access to sanitation, 10.4% in the ZF Mgcawu DM and 8.2% in the Northern Cape Province. It should be noted that since 2001 there have been improvements in access to sanitation within Kai !Garib LM, with the percentage of households reporting no access decreasing from 16.3% to 12% and the percentage of households reported to be using the bucket system dropping from 5.7% to 0.5% (StatsSA, 2001). Overall access to sanitation is detailed in Table 2.10.

Table 2.10: Access to sanitation (StatsSA, 2001 & 2011)

	Access to flush or chemical toilets		Pit Latrines		Bucket System		None	
	2001	2011	2001	2011	2001	2011	2001	2011
Kai !Garib LM	63.1%	72.7%	14.9%	14.8%	5.7%	0.5%	16.3%	12.0%
ZF Mgcawu DM	69.4%	73.3%	10.7%	10.7%	6.7%	5.6%	13.2%	10.4%
Northern Cape	58.5%	67.6%	18.4%	20.2%	10.0%	4.0%	13.1%	8.2%

Access to electricity

Households within Kai !Garib LM are reported to experience marginally better access to electricity than is generally experienced in the ZF Mgcawu DM and Northern Cape Province. 88.2% of households within Kai !Garib LM reported having access to electricity for lighting in comparison to 87.5% in the ZF Mgcawu DM and 86.7% for the Northern Cape Province. It should however be noted that a significant improvement in access to electricity for lighting has been experienced throughout the province, district and local municipality since 2001. Details of improvements in access to electricity for lighting are detailed in Table 2.11.

Table 2.11: Access to electricity for lighting (StatsSA, 2001 & 2011)

	Access to Electricity for lighting	
	2001	2011
Kai !Garib LM	70.2%	88.2%
ZF Mgcawu DM	71.7%	87.5%
Northern Cape	72.4%	86.7%

Access to healthcare

There are reported to be 95 clinics in the Northern Cape, with access to these facilities not comparing favourably to South Africa as a whole. There are 20 medical facilities in the Kai !Garib LM, including seven satellite clinics, four permanent clinics, six mobile clinics, two community healthcare clinics and one hospital (Kai !Garib IDP, 2013-2014). In relation to the study site, there is a satellite clinic in Augrabies and a permanent clinic in Riemvasmaak. The need for Government healthcare in the area is evident in that only 14.7% of the population have access to medical

insurance.

The key health challenges in the Kai !Garib LM are (Kai !Garib IDP, 2013-2014):

- HIV and AIDS increase and TB increase.
- High rate of teenage pregnancies.
- Lack of sufficient and qualified staff – limited skills amongst current nurses and nursing sisters to make the correct diagnosis and prescribe the correct medicine. Lack of sufficient facilities to render a proper health service to all communities in Kai !Garib.
- Irregular and insufficient services rendered by mobile clinics.
- Lack of necessary health equipment and medication at clinics.

HIV and AIDS-related deaths have been identified as the single biggest cause of death in the Northern Cape. This, in turn, has contributed to an estimated 10 000 AIDS orphans in the province. This said, a survey in 2011 found that HIV prevalence in the Northern Cape amongst the general population is estimated to be 17%, which is the lowest of all the provinces in South Africa. In addition, there has been a reported decrease in HIV prevalence among antenatal woman (South African National Aids Council, 2013).

2.4.4 Summary

From the aforementioned it is evident that there are numerous social and economic challenges being faced within the broader project area, especially relating to access to education, in particular, secondary and tertiary education and skills development. In accordance with the Renewable Energy Independent Power Producer Procurement Programme (REIPPP), there are various socio-economic development requirements among other development imperatives to which the project proponent needs to abide. The serious lack of development in the area presents numerous opportunities for such development.

2.5 The Aquatic Environment

The study area is at the lower end of the very large catchment of the Orange River, which drains a significant proportion of South Africa's land surface, as well parts of Lesotho (where the river is known as the Senqu), Botswana and Namibia. The catchment is designated Primary Drainage Region D by the Department of Water and Sanitation, and is included in Water Management Area No 14, Lower Orange River. The project area is in Quaternary Catchment D81A.

The dominant land use in the project site is conservation, but in the surrounding area formal agriculture dominates the greenbelt (riparian) area associated with the river that is serviced by a formal irrigation scheme. The Orange River represents one of the very few perennial rivers in an otherwise arid region, with the majority of the rivers and streams being seasonal in nature. The predominant surrounding vegetation types are Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. Lower Gariep Alluvial Vegetation is regarded as an Endangered vegetation type due to large-scale transformation through formal agriculture within the riparian zones of the Orange River within the region. The remaining vegetation units are regarded as Least Threatened (Mucina & Rutherford, 2006).

The Orange River is a highly altered system. The condition of the river, mainly in quantitative terms but also in respect of water quality, is strongly influenced by upstream developments and activities, especially construction of the Gariep and Vanderkloof dams, as well as dams constructed further upstream in the river system under the Lesotho Highlands Water Project. The South African dams have facilitated the development of irrigated agriculture along the river, which, together with the generation of electricity at the two hydropower stations attached to the dams and the provision of water for mining operations have significantly altered the flow regime of the river in terms of the volumes of water flowing in the river and its natural seasonality. The water quality regime of the river has been impacted by return flows from irrigated areas, and also by chemical pollution from

mining operations. Sediment loads in the river have been reduced by sediment deposition in the various impoundments along the river.

Two field surveys were undertaken during September 2013 and March 2015 to determine the present ecological state of the surface water resources that could potentially be impacted by the proposed development, and thereafter to determine the significance of the potential impacts resulting from the development of the proposed hydropower scheme.

2.5.1 Site 1: Diversion weir site

The site of the proposed diversion weir is located on the mainstem channel of the Orange River, approximately 2.4km upstream from the entrance to the Augrabies Falls measured along the channel centreline, in a section of the river that has a highly braided channel. Increasing flow rate in the river increases the diversity of habitat within this area, as the flow inundates side channels. These side channels offer varying levels of available aquatic habitat, as persistence of surface waters vary between channels. There is, however, a main watercourse, which was the focus of the study in this river segment, as flow within the river was mainly confined to this main channel.

Substrate at the site is dominated by bedrock in the main channel, with deposition of gravel and sand where hydraulic features induce deposition (that is, sheltered back eddies for example). Flow-depth classes within the main channel include fast deep, fast shallow, slow deep and slow shallow areas. Outside of the main channel are sheltered backwater areas that offer slow shallow and slow deep areas, where gravel deposition is common, together with cobbles and stones. The vegetation biotope included emergent marginal vegetation, predominantly reeds and roots. Aquatic vegetation was limited to an isolated occurrence of *Elodea* sp. that occurred out of current within a backwater area. Isolated patches of algae occurred as well. The gradient of the channel at the site was relatively low, so cascading flow and associated rapids and riffle habitat was uncommon. Flowing habitat was predominantly glides where constrictions in the channel occur, such as between large cobbles and boulders, but flow was predominantly flat (that is, slowly flowing, with a smooth and unruffled surface).

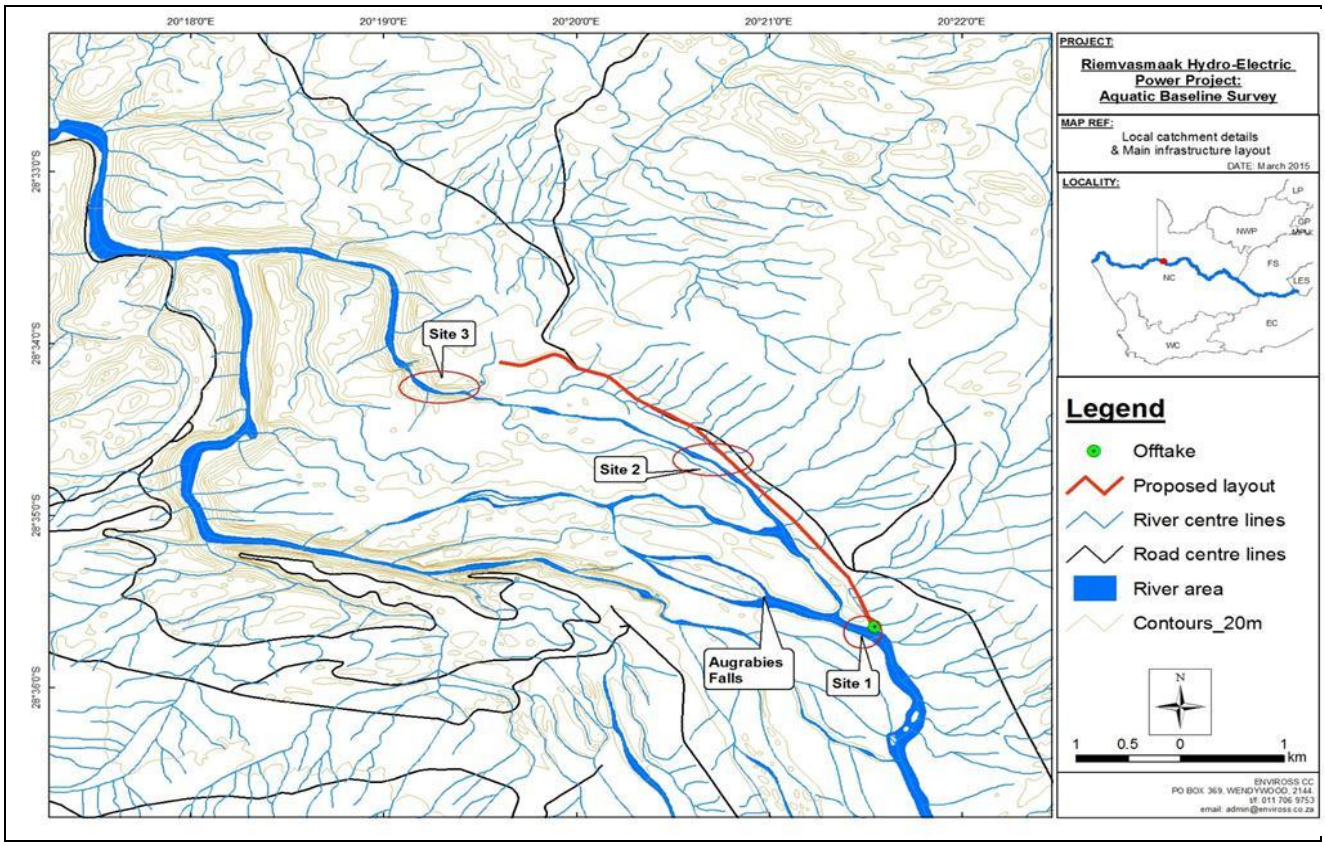


Figure 2.9: Locations of the aquatic survey sites/areas.

Flowing water habitat units were mostly associated with bedrock substrates, from which the conclusion was drawn that the habitat at the site is not highly productive and therefore not conducive to supporting a high diversity of aquatic macro-invertebrates. The site does, however, offer a diversity of habitat types/biotopes for supporting a variety of fish species and therefore a relatively good diversity and abundance is expected to occur within this section of the river.

Riparian vegetation and riparian zones are considered near-natural to natural due to the area being managed as a formal conservation area. The almost total lack of utilisation of the northern banks for tourism also means that this area remains in a good ecological state. Historical utilisation for inhabitation and livestock is shown by a small degree of transformation of the vegetation and remaining infrastructure. A low density of wildlife within the area utilise the riparian zones and therefore tracks occur, but this is regarded as a natural use of the riparian zones and is therefore not considered a driver of ecological change. Reed beds occur along the banks as well as colonising sandbars. Colonising sandbars trap further sediments and gravel, offering opportunity for encroachment to within the watercourse. This occurs in the absence of large flood events, which impact the upper sections of the river, above the falls.

2.5.2 Site 2: Seasonal side channel.

This section of the river is a seasonal side channel branching off the main watercourse. This channel was chosen as a study site as it was shown to offer persistent surface water that provided habitat for a diversity of aquatic organisms. It was observed that the channel was supplied with a minimal amount of flow that ensured that persistent pools remained full, with some flowing-type habitat between pools. This was true for the upper section of the channel. The water in the channel did tend to dissipate further along the channel, making for the assumption that the water percolated into the gravel beds. The flow rate in the main river channel was approximately 30 m^3/s at the time of the survey, and this side channel was still receiving some water. It is assumed that flow rates lower than this would result in a lack of surface water in the side channel, but the channel would still be fed to a degree by seepage. Releases from upstream impoundments means that flow rates less than 25 to 30 m^3/s are temporary within the system and therefore this side channel offers almost permanent habitat to aquatic organisms.

Plate 2.6: Views of typical habitat features at Site 1, the diversion weir

The substrate within this watercourse was mainly sand and gravel, cobbles, bedrock and large boulders. Aquatic vegetation included algae (largely due to limited flow and high nutrient loads), with marginal vegetation being dominated by emergent reed beds (*Phragmites australis*) and roots

of riparian vegetation. Flow-depth classes were dominated by slow shallow and slow deep habitat. Habitat diversity was considered high, but productivity of the channel is regarded as being limited by the general lack of flow. An increase in flow would see this channel support a high abundance and diversity of aquatic macro-invertebrates and fish.

2.5.3 Site 3: Main channel downstream of discharge.

The channel at this point is within the Orange River Gorge, and is characterised by a constricted, bedrock-dominated, steep-sided channel. The water is generally deep and fast-flowing. There is a distinct lack of riparian vegetation, instream and aquatic vegetation, which is largely due to the flooding regimes of the site. Because of the narrowing of the channel, the effects of flood events are more significant in this section of the river. The scouring effect of the floodwaters reduces the chances of vegetation being able to anchor sufficiently, which is a feature of the main watercourse of the Orange River Gorge. Sandbar and gravel bar deposition does occur where the river bends and hydraulic conditions induce deposition, but these are dynamic and are continually changing with the varying hydraulic conditions of the watercourse. This section of the river is difficult to sample because of dangerous conditions and flow-depth classes. The habitat types (biotopes) that are available make for the assumption that productivity is low and that limited diversity and abundance of aquatic macro-invertebrates would inhabit this section of the river. A diversity of fish species does occur within this section of the river, as they are able to exploit the varying hydraulic conditions to their advantage.

Plate 2.7: Typical habitat features of the side channel

2.5.4 EcoClassification

EcoClassification is the term used for the ecological classification process and refers to the determination and categorisation of the Present Ecological State (PES - the health of integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference

condition. The purpose of EcoClassification is to gain insight and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river. The EcoClassification and EcoStatus determination are undertaken according to DWA guidelines (Kleynhans & Louw, 2007, Module A). The steps followed in EcoClassification are as follows:

- Determine reference conditions for each component.
- Determine the PES for each component, as well as for the integrated EcoStatus.
- Determine the trend for each component, as well as for the EcoStatus.
- Determine the reasons for the PES and whether these are flow or non-flow related.
- Determine the Ecological Importance and Sensitivity (EIS) for the biota and habitats.
- Considering the PES and the EIS, suggest a realistic Recommended Ecological Category (REC) for each component, as well as for the EcoStatus.

The Present Ecological State (PES) of the river is expressed in terms of biophysical components:

- Drivers (physico-chemical, geomorphology, hydrology), which provide a particular habitat template; and
- Biological responses (fish, aquatic macro-invertebrates and riparian vegetation).

The standard South African Department of Water Affairs (DWA) River EcoClassification and EcoStatus Models were used to determine the Present Ecological State (PES) the EcoStatus category and the Ecological Importance and Sensitivity (EIS) (DWA, 2007 & 2008). Three aquatic survey sites were chosen that would best allow for determining any deleterious impacts emanating from the proposed development activities; the three sites, the locations of which are illustrated in Figure 2.9, were namely upstream of the impact, at the point of impact and downstream of the impact. The methodologies applied during the surveys were as follows:

- General riparian and habitat assessments:
  - Walk-about surveys at all survey sites;
- Aquatic habitat assessments:
  - *In situ* water quality (pH, oxygen content, dissolved oxygen, electrical conductivity (EC), total dissolved solids (TDS) and temperature);
  - Laboratory analysis of water samples taken at each survey site;
  - River IHI (Index of Habitat Integrity);
  - MIRAI (Macro-invertebrate Response Assessment Index);
  - FRAI (Fish Response Assessment Index);
  - VEGRAI (Vegetation Response Assessment Index).

2.5.5 Ecostatus

EcoStatus can be defined as the totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna (*modified from* Iversen *et al*., 2000). This ability relates directly to the capacity of the system to provide a variety of goods and services.

Various indices were utilised to assign the river reach in question a baseline PES rating, which included the River-IHI (River Index of Habitat Integrity), MIRAI (Macro-invertebrate Response Assessment Index), FRAI (Fish Response Assessment Index) and VEGRAI (Vegetation Response Assessment Index). The results from these various components are summarised in Table 2.12, where the overall EC (Ecological Category) is also provided.

Table 2.12: Summary of the EcoStatus models for the river segment studied

Component	EC (%)	Ecological Category
Index of Habitat Integrity Instream IHI Riparian IHI	 73.2% 62.4%	 C C
Fish Response Assessment Index	72.8%	C
Macro-invertebrate Response Assessment Index	62.9%	C
Vegetation Response Assessment Index	80.0%	B/C
ECOSTATUS		**C (Confidence: 4)**

The EcoStatus models all indicate that the river segment within the survey area has suffered various forms of degradation. The EcoStatus models ultimately place the system within a C category (Moderately modified – see Table 2.13 below).

Table 2.13: Generic interpretation of the EcoStatus categories (*from* Kleynhans & Louw, 2007)

Ecological Category	Description
A (90-100%)	Unmodified, natural.
B (80-89%)	Largely natural with few modifications. A small change in natural habitats and biota may have taken place, but the ecosystem functions are essentially unchanged.
C (60-79%)	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D (40-59%)	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E (20-39%)	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F (0-19%)	Critically /Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

2.5.6 Ecological Importance and Sensitivity

The use of biotic data in the assessment of the EIS considers the presence of rare and endangered species, unique species and species (including various life-history stages) with a particular sensitivity to flow (and flow-related water quality aspects) in combination with other ecological information on the study area. The EIS of a river is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological Sensitivity refers to the ability of the system to tolerate disturbance and its resilience once an impact has taken place (Kleynhans, 1999b). The results of the assessment are summarised in Table 2.14, from which it is concluded that the EIS of the system is rated as High.

Table 2.14: Summary of the relevant points of the EIS determination

Determinant	Score	Conf	Reason
PRIMARY DETERMINANTS			
Rare and endangered species	4	4	*Labeobarbus kimberleyensis; Austroglanis sclateri*
Populations of unique/isolated species	3	4	Aridity of the surrounding region means that the riparian zones and river habitat would be utilised by many unique and isolated species.
Species / taxon richness	3	4	Moderate/High – 7/11 of the expected fish species sampled. Rich diversity of birds and Herpetofauna and mammalian species
Diversity of habitat types or features	3	4	Moderate/High - instream biotopes diverse through interlinking channels, islands.
Migration/breeding and	2	4	The riparian zones form a greenbelt through an arid area that is

Determinant	Score	Conf	Reason
foraging site for wetland/riparian species			readily utilised for agriculture. It is therefore important to maintain this for maintenance of migrations and connectivity.
Sensitivity to changes in natural hydrological regime	3	4	Many fish species sampled are regarded as being flow dependent, with flow being a primary trigger for stimulating migratory movements.
Sensitivity to water quality changes	3	3	Some sensitive biodiversity noted within the aquatic habitat that would be impacted by deterioration of water quality.
Flood storage and energy dissipation	2	2	The Orange River has a large catchment area. There is limited capacity for flood attenuation due to limited flood plain interaction.
Base-flow augmentation and dilution	3	2	Large catchment with significant mean annual runoff, with the Orange River representing the main watercourse for the region.
MODIFYING DETERMINANTS			
Protected status	4	4	Aquatic and riparian habitats are statutorily protected and the survey area falls within a formally conserved area.
Ecological importance (rarity of size/type/condition)	2	3	The Orange River represents the main watercourse for the region and one of the very few perennial systems within an arid environment.
TOTAL	***32***		
MEDIAN	**3**	**3**	
		EIS	**High**

2.5.7 Water quality

In situ water quality parameters were measured at various points throughout the survey area to record average water quality parameter values for the surface waters at the time of the biological sampling. Samples from all of the biological survey sites were taken, which were done in triplicate, using a hand-held *Hanna Multi-parameter water quality meter: Model 9828*. The water quality parameters reported on are therefore the average values at each site. This was done to improve the accuracy of the data.

Results are presented in Table 2.15, and were compared with values in the South African Water Quality Guidelines for Aquatic Ecosystems (DWA 1996).

Table 2.15: *In situ* water quality results for each site taken during the March 2015 survey

Site	DO mg/ℓ	DO %	pH	Temp °C	mbar	EC µS/cm	TDS ppm	Salinity	ORP
Diversion weir	8.95	119.6	8.44	26.22	941.7	310	155	0.15	41.0
Side channel	6.23	86.4	8.39	26.84	942.0	314	158	0.15	35.4
Below discharge	8.88	117.2	8.46	26.48	946.4	312	157	0.15	44.0
Guideline Values (DWA, 1996)	>5 mg/ℓ	>60%	Between 6 and 8, and should not exceed 0.5 pH units or 5% of the natural pH range for a given system at any given time	Should not fluctuate by more than 2 °C or 10% of the normal daily cycle	-	TDS of <1000 ppm or not fluctuate by more than 15% of the normal range of a system within a 24hr cycle.			-

- The water temperatures recorded at the time of sampling ranged between 26.2 and 26.8 °C, and are what could be expected for the characteristics of the watercourse, climatic zones and the season and are therefore not expected to be a limiting factor on the survival of the aquatic organisms.
- The pH recorded throughout the survey area - – between 8.4 and 8.5 - was regarded as being within optimal ranges for supporting aquatic organisms, and is therefore not thought to be a limiting factor to supporting a diversity of aquatic biota.
- The system was characterised by slow to medium-flowing water, with gravel or sand substrates within the watercourses. Cascading flows were relatively rare. The general oxygen content was therefore expected to be within the average to lower bracket for aquatic ecosystems. Oxygen saturation levels ranged between 119.6% and 86.4%. The oxygen content of the surface waters throughout the survey area was not viewed as being a limiting factor to supporting aquatic diversity.

- The EC values throughout the survey area ranged between 310 and 314 µS/cm. The TDS of a system should not range by more than 15% for the "normal range" for any given system (DWA, 1996). The TDS values recorded at the time of biological sampling were between 155 and 158 ppm. Neither the EC nor TDS are considered to be limiting factors to supporting aquatic biota.

A full complement of water samples from each biological sampling site from was sent to a laboratory for analysis. The results for the diversion weir site are presented in Table 2.16 The values are compared to the South African Target Water Quality Guidelines (1996) values for aquatic ecosystems (DWA, 1996), and all of the values for all sites fall within the target ranges.

Table 2.16: Results of the laboratory water quality analyses (general water parameters).

Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification**
		RVM-Weir
Sample Number		22267
pH – Value at 25°C	WLAB001	8.1
Electrical Conductivity in mS/m at 25°C	WLAB002	51.6
Total Dissolved Solids at 180°C *	WLAB003	314
Suspended Solids at 105°C *	WLAB004	8.0
Turbidity in N.T.U	WLAB005	5.3
Total Alkalinity as $CaCO_3$	WLAB007	168
Chloride as Cl	WLAB046	46
Sulphate as SO_4	WLAB046	48
Fluoride as F	WLAB014	0.4
Nitrate as N	WLAB046	0.2
Total Coliform Bacteria / 100 mℓ *	WLAB021	6
E. Coli / 100 mℓ *	WLAB021	1
Free & Saline Ammonia as N	WLAB046	<0.2
ICP-MS Scan (Dissolved) [s]	---	See Table 2.17
% Balancing	---	99.0

Table 2.17 presents the results of the element scan of the constituents of the water. Two concerns are noted from a comparison of the results with the SA Water Quality Guidelines.

- Arsenic (As). The target value for an aquatic ecosystem is 0.01 mg/ℓ, making this value within the guideline value, but chronic effects are seen from 0.02 mg/ℓ and acute effects from 0.13 mg/ℓ. Although the tested value falls within the guideline values, it is an element that is highly toxic and therefore should be regarded as one of the target elements during routine monitoring surveys. This is an element used in pesticides and therefore it can be assumed that it has its source from agrochemical usage upstream of the project site.
- Chromium (Cr): Levels are considered high, measuring 0.141 mg/ℓ. Target guideline levels indicate less than 0.012 mg/ℓ, with chronic effects noted from 0.024 mg/ℓ. Acute effects occur at values exceeding 0.340 mg/ℓ. Aquatic organisms within the system could suffer limitations due to the effects of Chromium, which should be an element that should be the focus of routine monitoring in the future. This element is a by-product of the steel industry and its derivatives (such as electro-plating, for instance), and may also be released into the environment through mining. The most probable source of chromium in the water is through industrial effluent discharged upstream of the site.

Table 2.17: Elemental scan results of the laboratory water quality analyses.

Element	Units	Detection limits	RVM Weir site	Possible source	Element	Units	Detection limits	RVM Weir site	Possible source
Ag	mg/ℓ	<0.01	<0.01		**Na**	mg/ℓ	<0.01	45.4	Agrochemical
Al	mg/ℓ	<0.01	<0.01		**Nb**	mg/ℓ	<0.01	<0.01	
As	mg/ℓ	<0.01	0.003	Slightly high. Source: Agrochemical pesticide	**Nd**	mg/ℓ	<0.01	<0.01	
Au	mg/ℓ	<0.01	<0.01		**Ni**	mg/ℓ	<0.01	<0.01	
B	mg/ℓ	<0.01	0.061	Natural geology	**Os**	mg/ℓ	<0.01	<0.01	
Ba	mg/ℓ	<0.01	0.060	Natural geology	**P**	mg/ℓ	<0.80	<0.80	
Be	mg/ℓ	<0.01	<0.01		**Pb**	mg/ℓ	<0.01	<0.01	
Bi	mg/ℓ	<0.01	<0.01		**Pd**	mg/ℓ	<0.01	<0.01	
Ca	mg/ℓ	<0.01	34.4	Natural geology	**Pr**	mg/ℓ	<0.01	<0.01	
Cd	mg/ℓ	<0.01	<0.01		**Pt**	mg/ℓ	<0.01	<0.01	
Ce	mg/ℓ	<0.01	<0.01		**Rb**	mg/ℓ	<0.01	<0.01	
Co	mg/ℓ	<0.01	<0.01		**Re**	mg/ℓ	<0.01	<0.01	
Cr	mg/ℓ	<0.01	0.141	Slightly high. Source: Mining or industry.	**Ru**	mg/ℓ	<0.01	<0.01	
Cs	mg/ℓ	<0.01	<0.01		**Sb**	mg/ℓ	<0.01	<0.01	
Cu	mg/ℓ	<0.01	<0.01		**Sc**	mg/ℓ	<0.01	<0.01	
Dy	mg/ℓ	<0.01	<0.01		**Se**	mg/ℓ	<0.01	<0.01	
Er	mg/ℓ	<0.01	<0.01		**Si**	mg/ℓ	<0.01	2.15	Natural geology
Eu	mg/ℓ	<0.01	<0.01		**Sm**	mg/ℓ	<0.01	<0.01	
Fe	mg/ℓ	<0.01	0.025	Natural geology	**Sn**	mg/ℓ	<0.01	<0.01	
Ga	mg/ℓ	<0.01	<0.01		**Sr**	mg/ℓ	<0.01	0.242	Natural geology
Gd	mg/ℓ	<0.01	<0.01		**Ta**	mg/ℓ	<0.01	<0.01	
Ge	mg/ℓ	<0.01	<0.01		**Tb**	mg/ℓ	<0.01	<0.01	
Hf	mg/ℓ	<0.01	<0.01		**Te**	mg/ℓ	<0.01	<0.01	
Hg	mg/ℓ	<0.01	<0.01		**Th**	mg/ℓ	<0.01	<0.01	
Ho	mg/ℓ	<0.01	<0.01		**Ti**	mg/ℓ	<0.01	0.014	Natural geology
Ir	mg/ℓ	<0.01	<0.01		**Tl**	mg/ℓ	<0.01	<0.01	
K	mg/ℓ	<0.01	2.34	Natural geology, but may be increased through fertilisers	**Tm**	mg/ℓ	<0.01	<0.01	
La	mg/ℓ	<0.01	<0.01		**U**	mg/ℓ	<0.01	<0.01	
Li	mg/ℓ	<0.01	<0.01		**V**	mg/ℓ	<0.01	<0.01	
Lu	mg/ℓ	<0.01	<0.01		**W**	mg/ℓ	<0.01	<0.01	
Mg	mg/ℓ	<0.01	22.2	Natural geology	**Y**	mg/ℓ	<0.01	<0.01	
Mn	mg/ℓ	<0.01	<0.01		**Yb**	mg/ℓ	<0.01	<0.01	
Mo	mg/ℓ	<0.01	<0.01		**Zn**	mg/ℓ	<0.01	<0.01	
					Zr	mg/ℓ	<0.01	<0.01	

Water quality results indicated that the river segment has retained relatively good water quality and that water quality is not regarded as a limiting factor to supporting aquatic biodiversity. Agrochemicals are thought to have an impact on aquatic invertebrates within the system, but these compounds were not tested for.

2.6 Land Ownership, Land Management and Zoning

Documentation relating to these issues is included in Appendix G.

This section addresses issues around the ownership, responsibility to manage and zoning of the various portions of land on which the proposed project will be constructed, and through and over

which power lines will be routed.

2.6.1 Hydropower Station Infrastructure

The following sections provide brief descriptions of the main elements of infrastructure that will be located on three portions of land, as shown on Figure 2.10.

The applicant has commissioned a Legal Opinion on all aspects of the ownership and management of these portions of land (see Appendix G-1 for the full text of the Opinion). The key conclusions from the Opinion are summarised after the overview description of the infrastructure on each portion of land, together with actions that have been implemented or initiated with respect to ensure that all legal requirements can be met in respect of the construction and operation of the project.

The Legal Opinion discusses the proposed buffer zone around the national park, established by SANParks in terms of the Strategy on buffer zones for National Parks, and published for general information in February 2012 as GN 26025. The buffer zone is illustrated in the AFNP Management Plan as Map 6. The map is reproduced as Figure 2.10a below, from which it can be seen that this very large area includes Portion 1 of Farm Riemvasmaak, which is indicated in the legend as *Melkbosrant Area*, and as *SANParks – Managed*.

The Legal Opinion concludes that, since the buffer zone has not been declared as a protected environment in terms of the NEM: PAA, it exists as a policy intention by SANParks, and does not enjoy statutory protection.

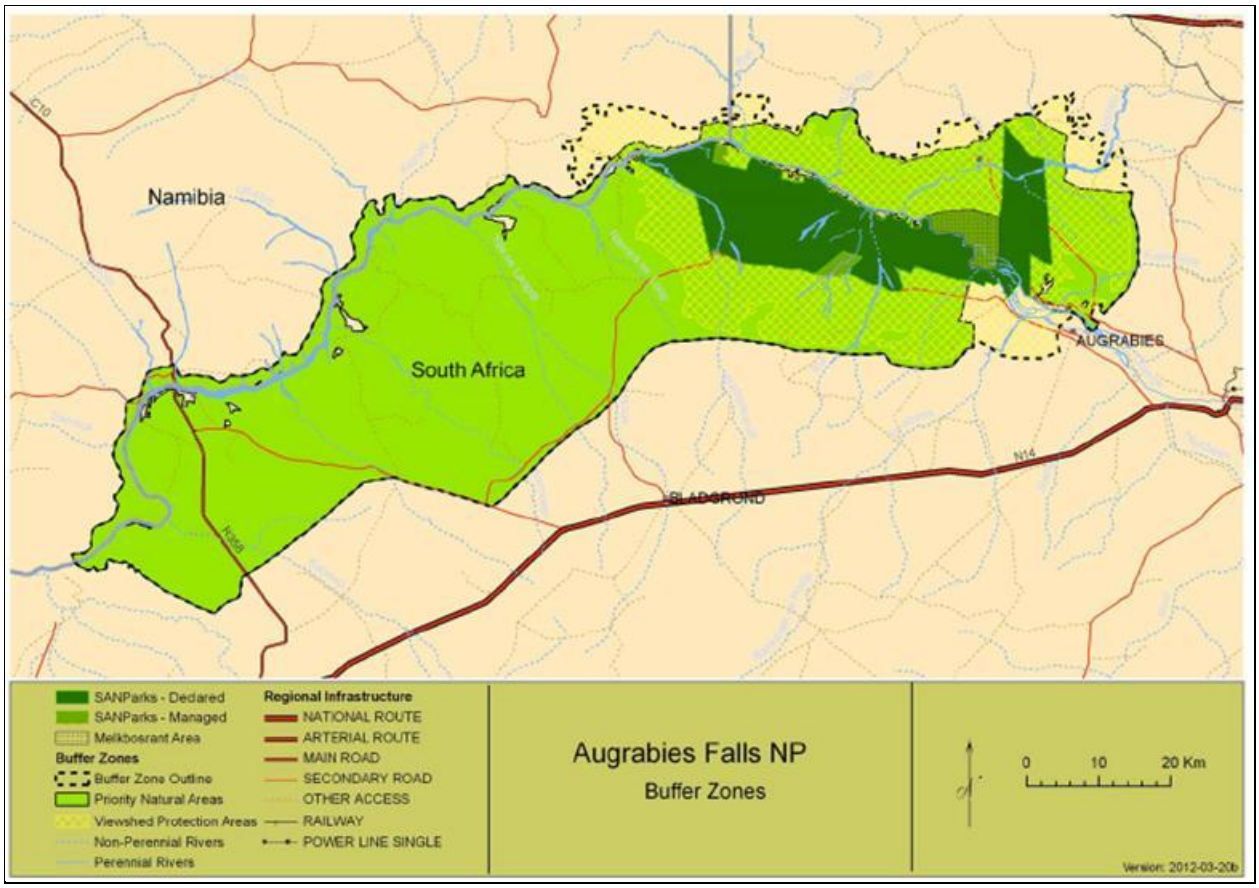


Figure 2.9a: Augrabies Falls National Park Buffer Zones
Source: AFNP Management Plan 2-13-2023, November 2012

Portion 1 of farm Riemvasmaak No 498

Infrastructure

- The downstream ±1km of the headrace.
- The headpond, overflow spillway and penstock forebay.
- The penstocks.
- The powerhouse and electrical infrastructure.
- The tailrace and tailrace outfall into the Orange River.
- About 2km of the underground transmission line.
- About 2km of the access road.
- An access road or haulage way to the tailrace outfall point.

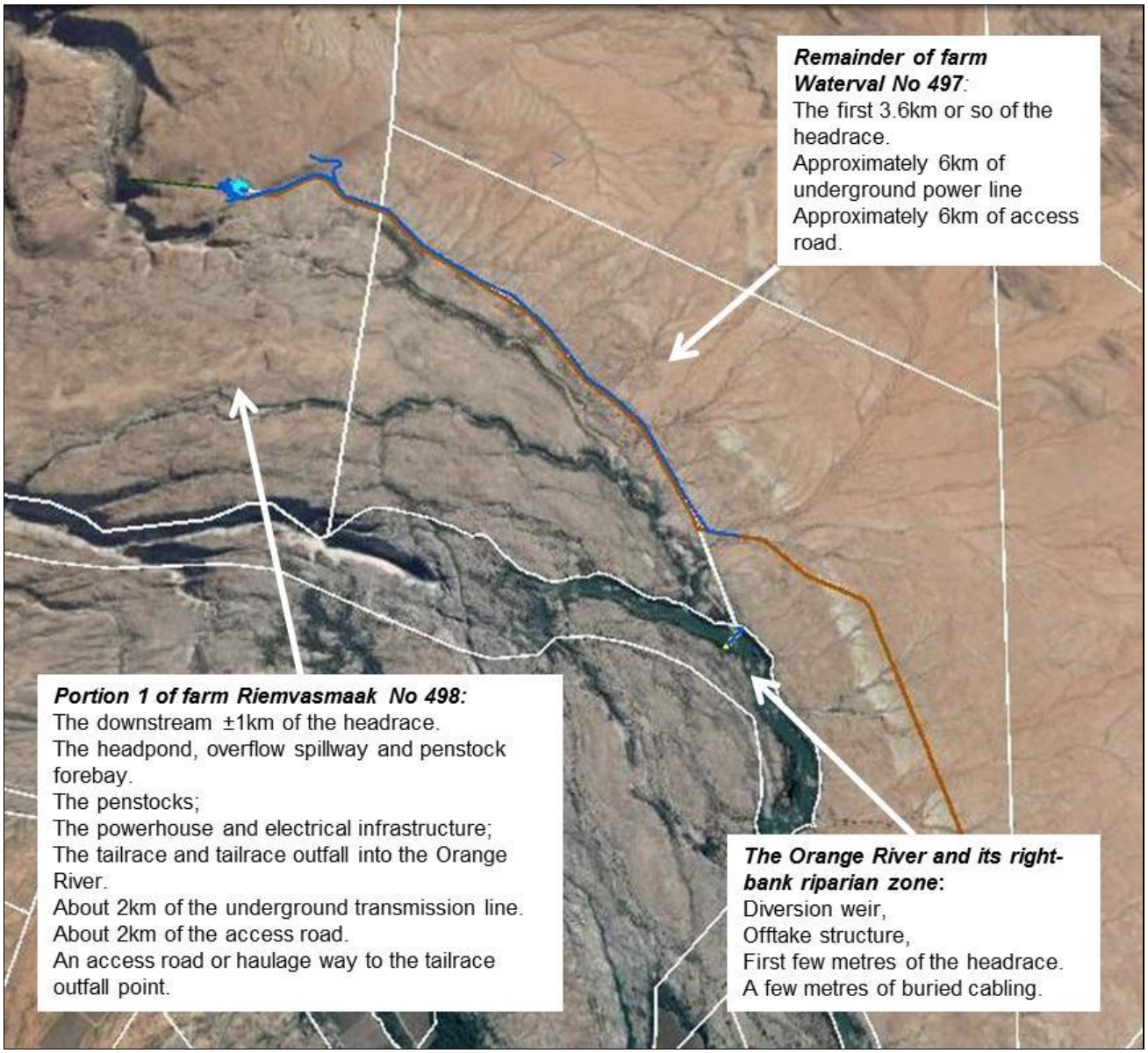


Figure 2.10: Hydropower station infrastructure and property boundaries

Legal Opinion

(i) Portion 1 of the farm Riemvasmaak No 498 does not exist in law as a separate property, since no Certificate of Registered Title was taken out, and the portion still forms part of the farm Riemvasmaak.

(ii) The registered owner of the farm Riemvasmaak is the Riemvasmaak Gemeenskap-

ontwikkelingstrust (Community Development Trust), in terms of Deed of Transfer T818/1996 (Appendix G-2).

(iii) The area of land known as Portion 1 of the farm Riemvasmaak (also known as Melkbosrand) was deproclaimed as a national park in on 28th May 2004 by a declaration published in Government Notice 657 in Government Gazette 26374.

(iv) There is no agreement between the local community and the Minister that has been ratified by Parliament, as contemplated in the definition of a national park in the NEM: Protected Areas Act.

(v) There is no evidence that the land has been declared to be a national park in terms of section 20 of the NEM: PAA.

(vi) The the land has not been re-established as part of the AFNP since its exclusion in 2004.

(vii) The Management Plan 2012-2023 for the AFNP, November 2012, provides for a buffer zone that includes Portion 1 of farm Riemvasmaak, but the buffer zone has not been declared as a protected environment in terms of s51 the NEM: PAA.

(viii) The land is currently managed by SANParks in terms of "*an agreement negotiated by the technical team of both parties concluded in March 1998. The parties are currently negotiating such co-management agreement.*" A copy of a document entitled *Konsep vir Bespreeking deur Onderhandelsing Komittee op 7 Maart 1998* is included as Appendix G-3, but there does not appear to be a formal co-management agreement in place.

(ix) The Trustees may enter into a lease agreement over the land provided they have been empowered to do so by a duly approved development plan or by a resolution taken at a properly constituted special general meeting of the specified beneficiaries of the trust.

Zoning

(x) The land is currently zoned Agriculture Zone 1 in terms of the Kai !Garieb LM Town Planning Scheme (Appendix G-4).

Actions

- A resolution to enter into a lease agreement with RVM1 Hydro Electric Power (Pty) Ltd was taken by the Trust on 6th June 2015 (Appendix G-5).
- A Lease Agreement was signed on 17th July 2015 (Appendix G-6).
- Given the extent of the infrastructure it will be necessary to apply for a temporary departure from the current zoning for the whole period of construction of underground works, reverting to the current zoning once construction is completed and the land surface is rehabilitated (Appendix G-7).
- Above-ground works will require an application for rezoning to Special Zone (Appendix G-7).

Remainder of farm Waterval No 497:

Infrastructure

- The first approximately 3.6km or so of the headrace.
- Approximately 6km of underground power line.
- Approximately 6km of access road.

Legal Opinion

(xi) The registered owner of the Remaining Extent of the farm Waterval 497 is the Republic of South Africa, by virtue of Deed of Transfer T5921/1912 (Appendix G-7).

(xii) The property was included within the boundaries of the Augrabies Falls National Park when the boundaries were initially defined and declared in Government Notice No 216, in Government Gazette 1506 dated 5 August 1966.

(xiii) The inclusion of the property in the national park was confirmed in terms of the definition of the area of the park in Schedule 1 of the National Parks Act, 57 of 1976.

(xiv) The status of the national park was confirmed in the definition of national park in the NEM: PAA.

(xv) According to s4 of the Government Immovable Asset Management Act 19 of 2007 The Minister of Public Works is responsible for managing immovable assets that vest in the national government.

(xvi) The Regional Office of the Department of Public Works has confirmed in writing (Appendix G-9) that:

- The property is owned by the Republic of South Africa;
- The property is part of the Augrabies Falls National Park;
- The Department (of Public Works) is the custodian of all National properties;
- The farm is reserved for National Parks Board;
- An application for a servitude across the land must be submitted to the Kimberley office of DPW "to ensure that internal processes are followed"; and
- National Parks' permission must be obtained before any work can commence in the park.

(xvii) The NEM: PAA does not impose a blanket prohibition on development or construction in a national park. The Act permits the management authority of a national park to carry out or allow-a commercial activity in the park, or an activity aimed at raising revenue; subject to the management plan being amended.

(xviii) The fact that the land forms part of the AFNP does not preclude the applicant from entering into an agreement with the landowner - the State, through DPW - in order to procure real rights – a servitude - in respect of the land.

Zoning and other information

(xix) The land is currently zoned Open Space Zone III –Conservation Area in terms of the Kai !Garieb LM Town Planning Scheme (Appendix G-10).

(xx) No public access to the land is permitted. The bridge across the river from the south bank was destroyed by a recent large flood, and the gated access to the area from the unpaved road on the north side of the river is kept locked at all times

Actions

- Given the extent of the infrastructure it will be necessary to apply for a temporary departure from the current zoning for the whole period of construction of underground works, reverting to the current zoning once construction is completed and the land surface is rehabilitated (Appendix G-7).
- Above-ground works will require an application for rezoning to Special Zone (Appendix G-7)..
- A copy of the Draft EIA Report has been provided to DPW Kimberley office, together with preliminary design drawings for the offtake structure and headrace conduits, and a presentation outlining the impacts and benefits of the project. This constitutes the first stage of an application for a servitude across land owned by the Republic of South Africa.

The Orange River and its right-bank riparian zone:

Infrastructure

- Diversion weir,
- Offtake structure,
- First few metres of the headrace.

- A few metres of buried powerline.

Legal Opinion

(xxi) The Surveyor-General diagrams of the river appear to show that the boundaries of the properties on both sides of the river extend to the "inner edge" of the Orange River.

(xxii) The land traversed by the river in this area does not fall in the ownership of either the owner of the properties on the river banks, but is unsurveyed and unregistered land that is owned by the State.

(xxiii) According to the definition of the area of the Park in the National Parks Act, 1976, the river channel and its riparian zones in this area are included in the boundaries of the park.

(xxiv) If a water use licence is issued for the project by the Department of Water and Sanitation, the holder of the licence is entitled to claim a servitude from the owner, in this case represented by the Minister of Public Works, in terms of the provisions of Part 2 of Chapter 13 and Schedule 2 of the National Water Act, 36 of 1998.

Zoning

(xxv) The zoning of this land is not known, but it is currently assumed to be zoned Open Space Zone III –Conservation Area, because it is included in the national park.

(xxvi) All infrastructure on this land is above ground, and it will be necessary to apply for rezoning to Special Zone (Appendix G-7).

Actions

- All infrastructure on this land is above ground, and it will be necessary to apply for rezoning to Special Zone (Appendix G-7).
- An application for a water use licence has been prepared for the construction of the diversion weir and offtake works, and submitted to the Department of Department of Water and Sanitation in accordance with the requirements of the National Water Act.
- A non-binding letter has been received from DWS confirming that sufficient water is available for the construction and operational phases of the project's lifetime (Appendix G-11).

2.6.2 Overhead Transmission Lines

The route of the overhead transmission lines from the boundary of Remainder of farm 497 Waterval to the connection into the national grid is shown on Figure 2.11. The route crosses a number of parcels of land, which are listed in Table 2.18 below, together with the names of the registered owners of the land.

Table 2.18: Properties and ownership on the route of the overhead transmission lines

Property Number and Description	Registered Owner	Remarks
492 / 1 - farm Omdraai	Riemvasmaak Community Development Trust	Farm number is now 642 after consolidation and subsequent further sub-division
Orange River	Republic of South Africa	
2397 - Erf	Mr Gert Adriaan Heese	Confirmation of Notification in App G
2398 -Erf	Vaalkop Eiland Boerdery	Property sold to Mr Willem C du Toit Confirmation of Notification in App G
16 / 107 – farm Orange Fall	Oosthuizen Krige Familietrust	Care of Mr Riaan Oosthuizen Confirmation of Notification in App G
1629 - Erf	Noudonzies Eiland Trust	Care of Mr RK Oosthuizen, Mr GM< Els and Mr FJ Oosthuizen
Orange River	Republic of South Africa	
1302 - Erf	Hannes Kruger Familie Trust	Care of Mr CH Oosthuizen
2136 - Erf	Mr CH Oosthuizen	Confirmation of Notification in App G
2091 - Erf	Groenheuwel Trust	Care of Mr AS Spangenberg

Property Number and Description	Registered Owner	Remarks
		Confirmation of Notification in App G
2158 - Erf	Kakamas Weiveldeenheid Nommer Een Ltd	Subdivided but not yet registered Now owned by Groenheauvel Trust Care of AS Spangenberg Confirmation of Notification in App G
2159 - Erf	Kakamas Weiveldeenheid Nommer Een Ltd	
2197 - Erf	Groenheuwel Trust	Care of Mr AS Spangenberg Confirmation of Notification in App G

Confirmation that the land owners have been notified of the intention to construct the powerline across their land is included in Appendix G

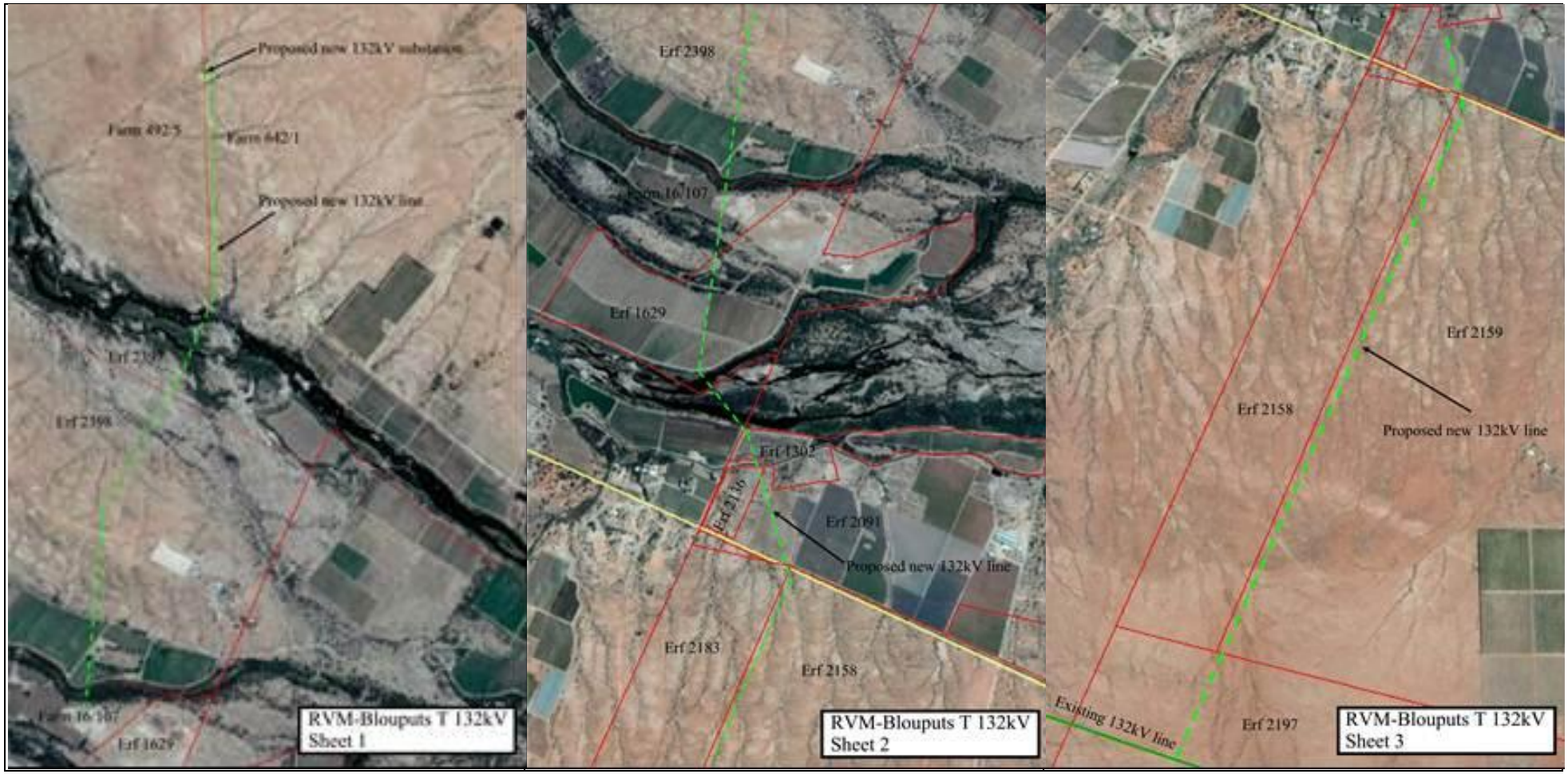


Figure 2.11: Route of 132kV overhead power line showing property identifiers

3 PROJECT DESCRIPTION

3.1 General Project Description

3.1.1 Infrastructure

In broad terms the project will entail the construction of infrastructure comprising:

(a) A low diversion weir across the Orange River upstream of the Augrabies Falls.
(b) An off-take structure at the weir to facilitate diversion of water from the river.
(c) A conduit – the headrace - to convey water from the intake structure to the penstock head pond.
(d) A head pond and power station intake structure - forebay.
(e) Vertical (or very steep) penstocks – pipes - to transfer the water from the head pond to the power chamber.
(f) An underground power chamber containing up to four Francis turbines.
(g) An underground tailrace and outlet works to convey water from the power chamber back to the river channel.
(h) Haul roads to facilitate access for construction and the removal of excavated material off site for disposal or re-use.
(i) A high voltage (HV) power line to evacuate the power from the power station to the national grid.
    - Underground cable across portions 1/497 and Rem 498 (approximately 7.5 km); and
    - Overhead power lines across the river, over private land to the connection point (approximately 8 km).
(j) A transformer yard and mini substation located at the headpond and a new substation.
(k) Fencing as required for public safety.

In addition, a previously existing pedestrian bridge across the river channel a short distance upstream of the Augrabies Falls, which was washed away by a recent flood event, might be rebuilt as part of the hydropower project. Figure 3.1 is a pictorial representation of the project, which shows the use of the vertical height of the cliffs at the Dry Falls (see Figures 3.2 and 3.4) – the head – to drive the turbines in the underground power chamber before the water diverted from the river is returned to the Orange River downstream of the Dry Falls.

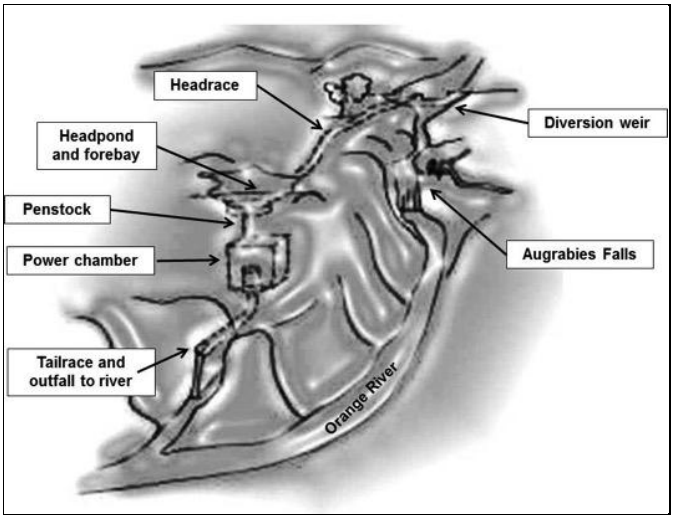


Figure 3.1: Pictorial representation of the Riemvasmaak Hydroelectric power project
Source: Adapted from Aurecon 2013 / Nick West (Entura)

The proposed layout of the infrastructure and the route of the underground and above-ground power lines are shown on Figures 3.2, 3.3, 3.4 and 3.5 respectively. Each element of infrastructure is described in more detail later in this chapter.

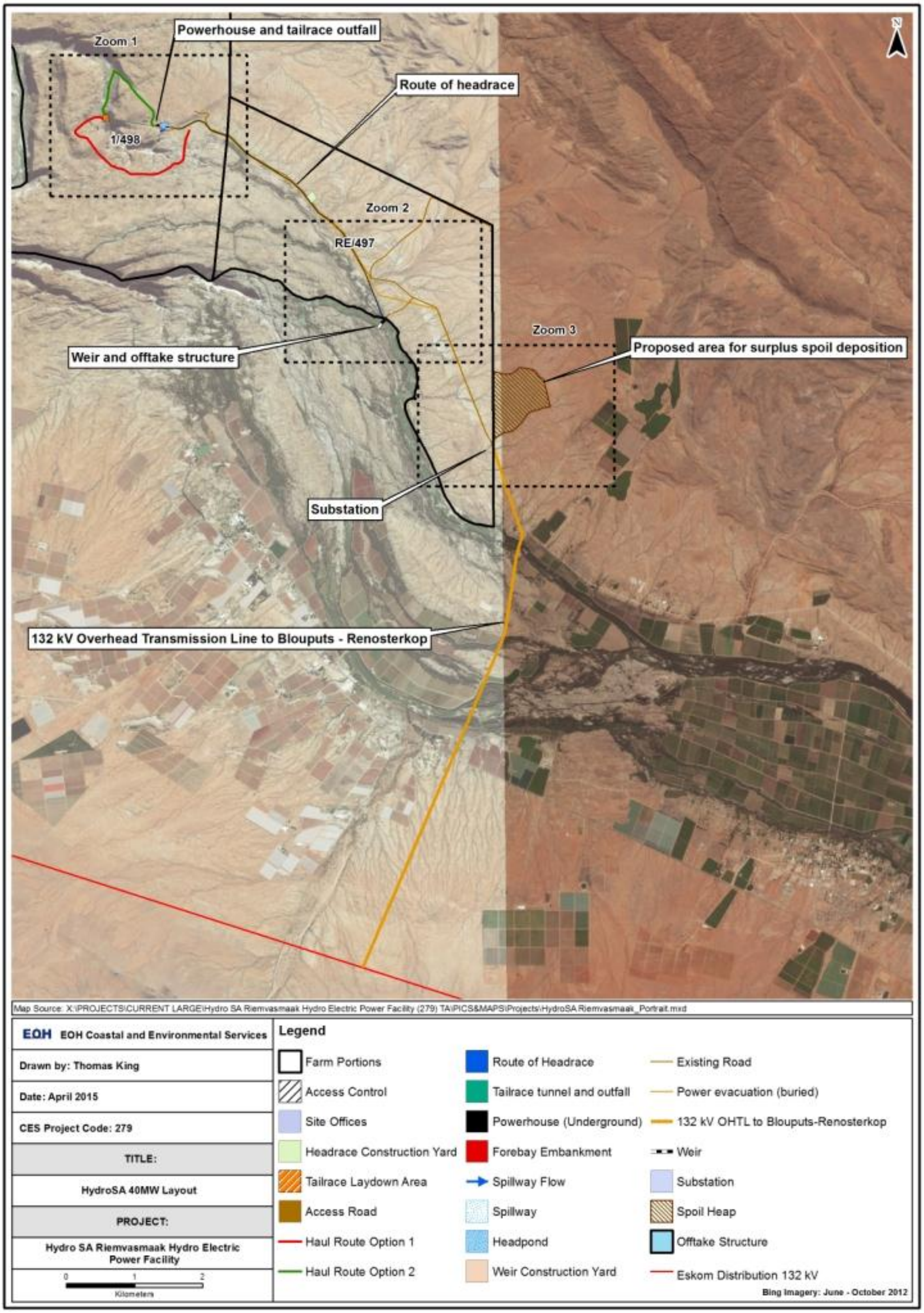


Figure 3.2: General layout of project infrastructure from diversion weir to tailrace outfall
See Figure 3.3 for weir site (Zoom 2); and Figure 3.4 for headpond, powerhouse and tailrace site (Zoom 1)

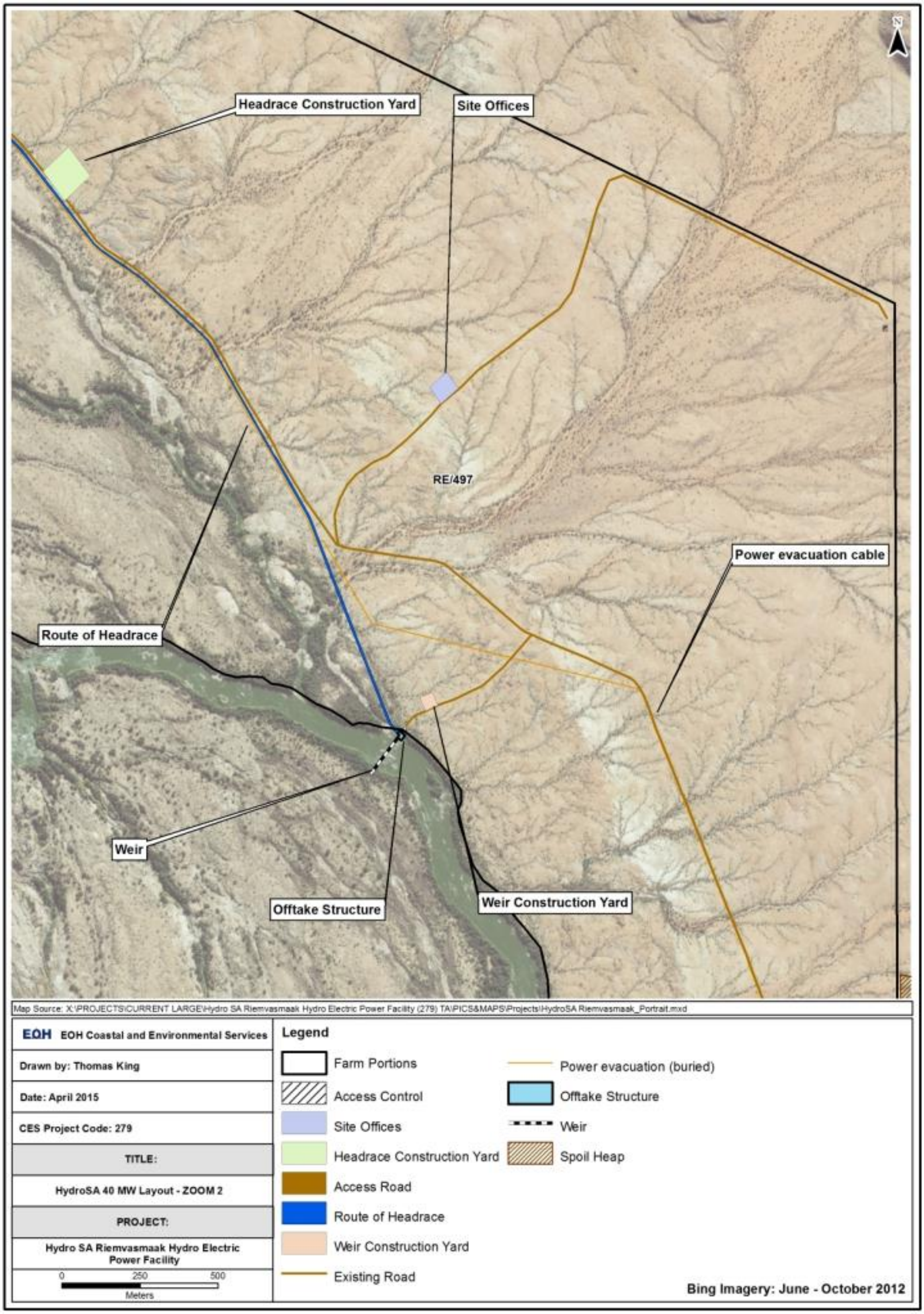


Figure 3.3: Layout of weir and offtake structure

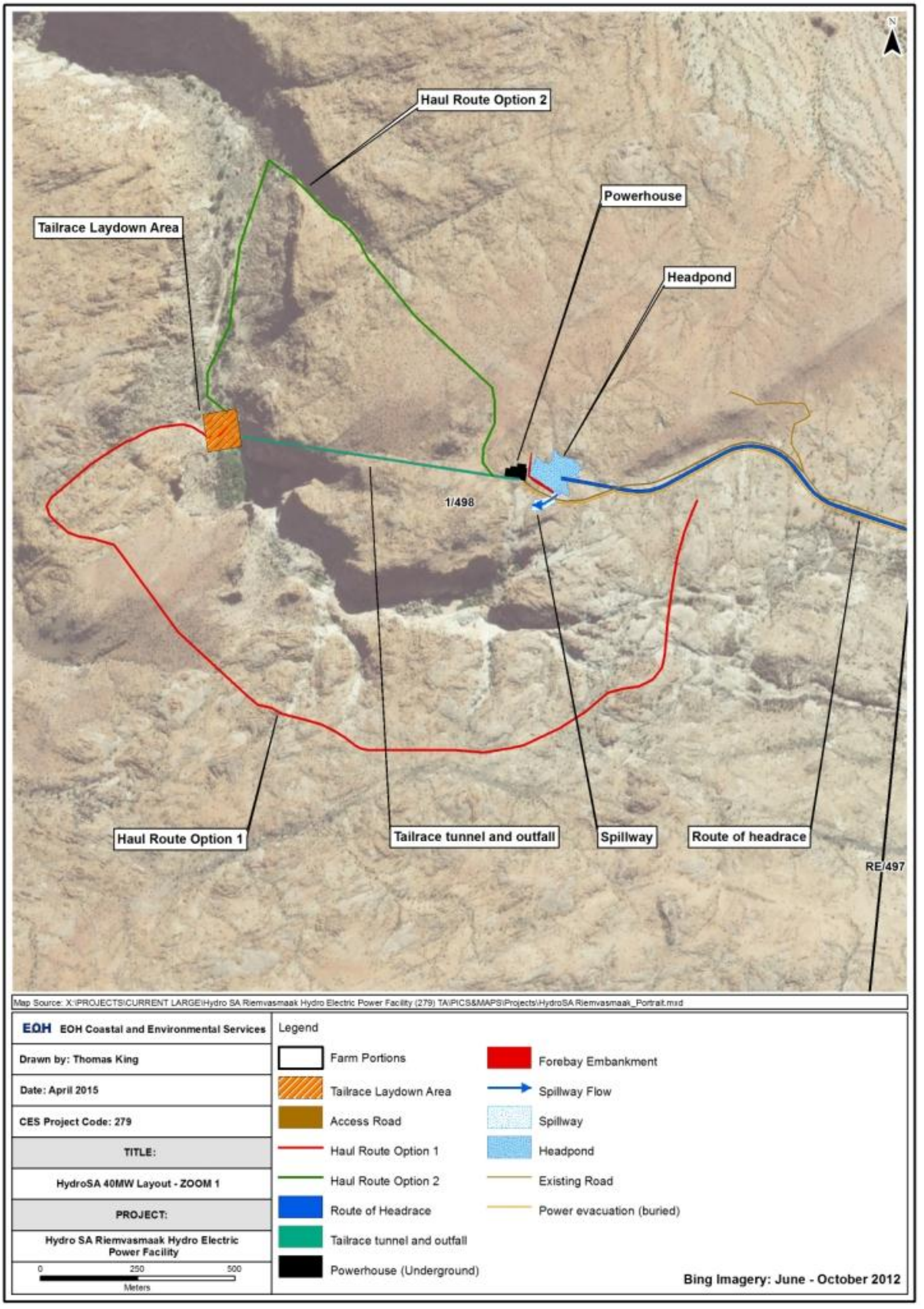


Figure 3.4: Layout of headpond, underground power chamber, tailrace tunnel and outfall

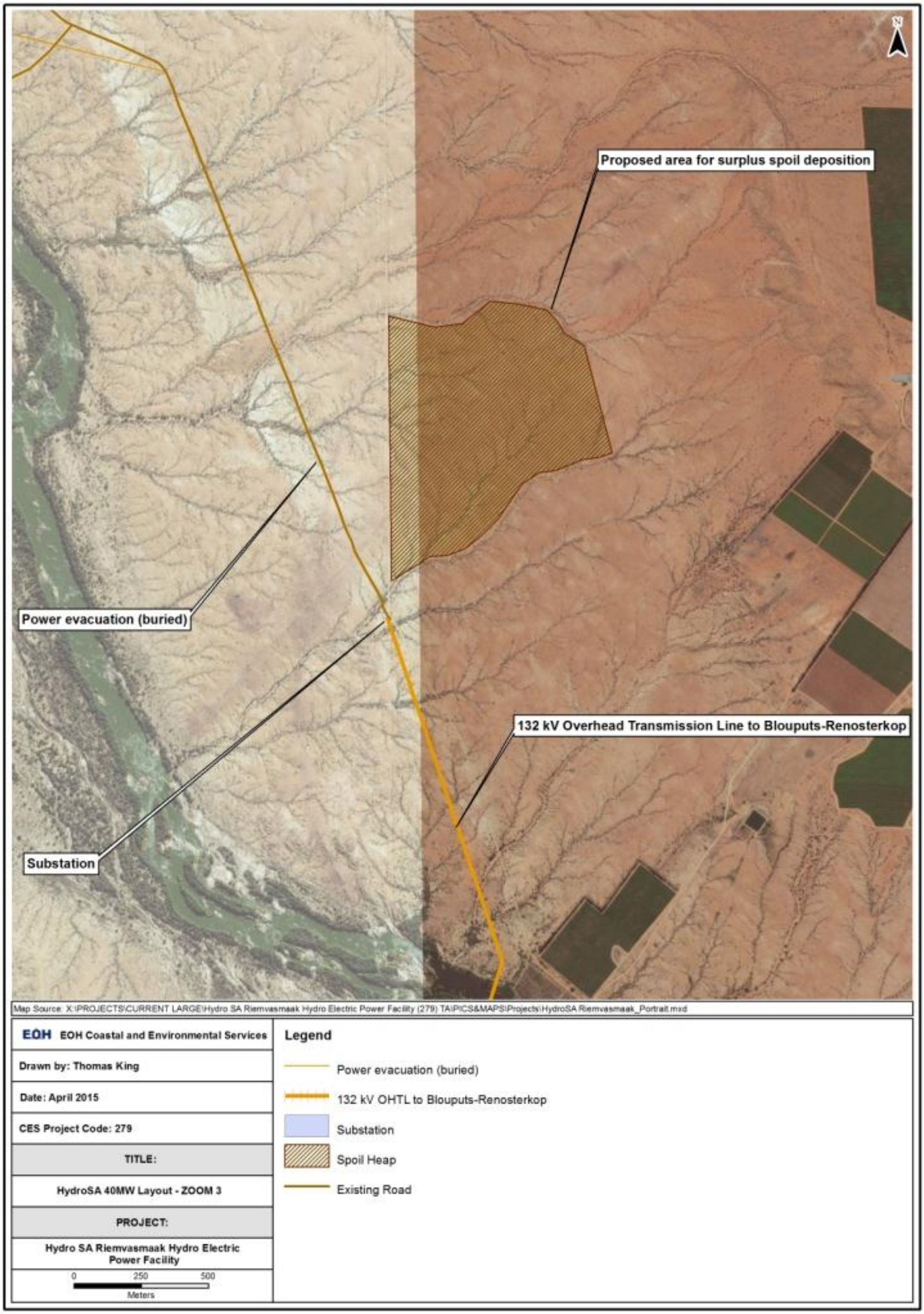


Figure 3.5: Location of the substation and proposed area for surplus spoil deposition

3.1.2 Portions of land occupied by project-related infrastructure

Note: *A detailed account of the ownership of all portions of land directly impacted by the project is provided in section 2.6. Where appropriate a description of the management arrangements for certain portions of land is also given.*

As can be seen from Figure 3.2 all the major elements of the infrastructure except the "downstream" sections of the powerlines by which power will be evacuated from the power house will be constructed on three portions of land.

- **Orange River and its right-bank riparian zone:** The weir, offtake structure and the first few metres of the underground headrace will be constructed on this land.

- **Farm 497 - Remainder (0) of Farm Waterval**: Infrastructure to be constructed on this portion of land will comprise:
  - The first 3.6km of the underground headrace.
  - Approximately 6km of underground power line
  - Approximately 6km of access road.

- **Farm 498 – Portion 1 of Farm Riemvasmaak:** Infrastructure to be constructed on this portion of land will comprise:
  - The downstream 1km of the underground headrace;
  - The headpond;
  - The penstocks;
  - The underground powerhouse and electrical infrastructure;
  - The tunnelled tailrace and tailrace outfall into the Orange River;
  - About 2km of the underground transmission line;
  - About 2km of the access road;
  - An access road or haulage way to the tailrace outfall point.

The section of the underground powerline that runs south-east from the site of the weir and offtake structure (see Figure 3.3) crosses Waterval Rem 497 at the south-eastern boundary, where it enters a substation on Portion 1 of Farm 492 (subsequently renumbered 642 after consolidation and further subdivision). Thereafter the power line is above ground, and crosses a number of parcels of private land, and the Orange River, before it is connected to an existing 132kV Eskom power line between Renosterkop and Blouputs.

3.2 Details of Infrastructure

3.2.1 Diversion weir

Location

The weir will be constructed across the mainstem channel of the Orange River, approximately 2.4km upstream from the entrance to the Augrabies Falls, measured along the channel centreline (see Figure 3.3), about 1.8km as the crow flies.

Purpose

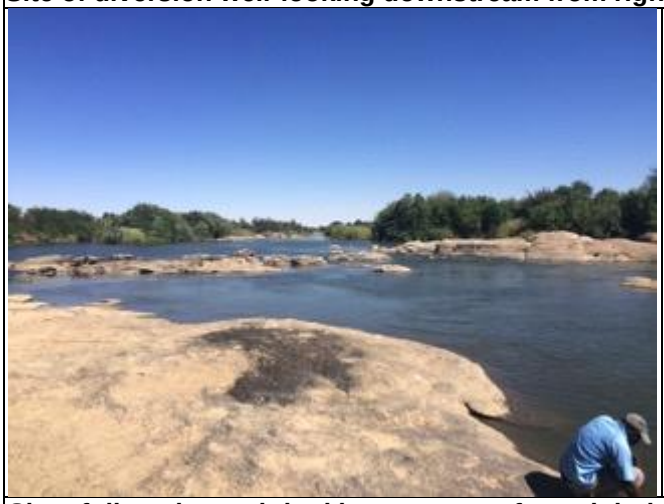
The purpose of the weir is to divert a portion of the water flowing in the Orange River into the HPP offtake structure. The maximum rate of diversion from the river to the hydropower station will be $38m^3/s$.

Design

The weir will be a low concrete wall - the non-overspill crest of the weir, the highest part of the structure, will not be more than 5m above the lowest point on the river bed immediately downstream of the weir – and will be approximately 160m long.

Most of the overspill crest (approximately 120m on the left side of the channel) will be a Crump profile (see Figure 3.7 below) with crest level at 619.0m above mean sea level (amsl). This profile minimises the amount of debris caught on the sloping upstream face of the weir, and is also safer for canoeists crossing the weir going downstream. A 7.5m-wide low-flow slot left of the channel centreline, with a broad crested profile (see Figure 3.7 below) at level 616.0m, will allow the agreed environmental flow of 30m^3/sec to pass through the weir structure unimpeded. A 30m-long "hydrological hydropower weir" on the right side of the channel, with crest level at about 618.0m amsl, is designed to ensure that at least 30m³/s flows through the low-flow slot before water is diverted into the HPP headrace. The way in which the weir facilitates flow division between the river and the headrace is described in section 3.4. Additional mechanical control over flows entering the headrace is provided in the offtake structure, which is discussed in the following section.

Site of diversion weir looking downstream from right bank (above)



Site of diversion weir looking upstream from right bank (above)

Plate 3.1: Site of proposed diversion weir

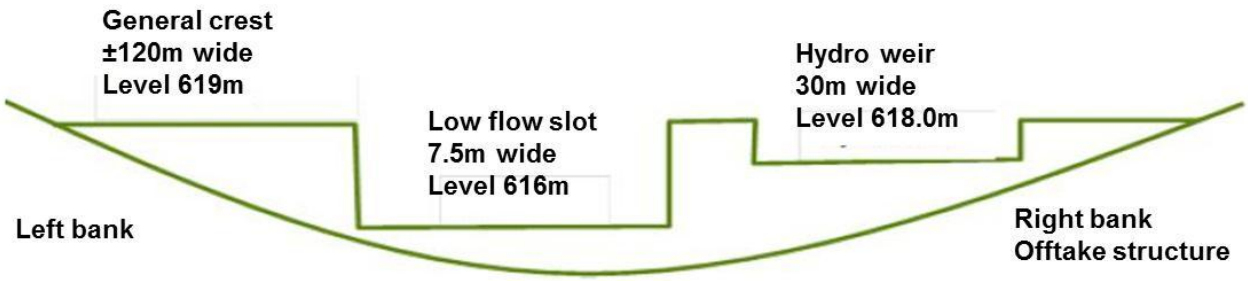


Figure 3.6: Schematic elevation of diversion weir looking downstream

Source: Adapted from Aurecon 2013

Details of the way in which flow approaching the diversion weir is split between the Augrabies Falls and the HPP headrace are provided later in this section.

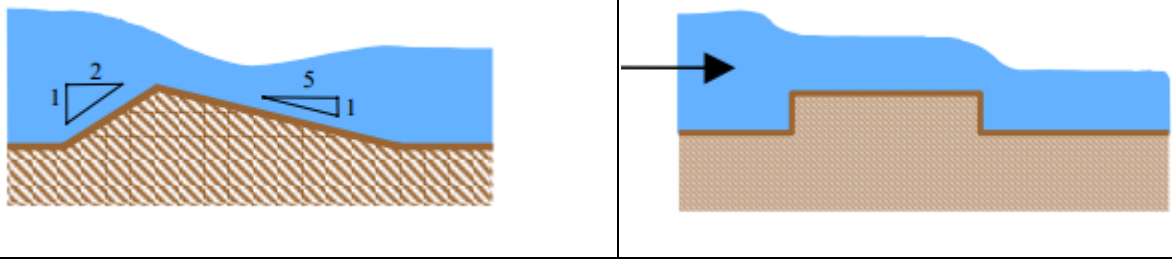


Figure 3.7: Weir section profiles: Crump (left) Broad-crested (right)

Source: River Weirs – Good Practice Guide Section A, Rickard et al, UK Environment Agency R&D Publication W5B-023/HQP 2003

The weir will be similar in appearance to the DWS hydrological gauging weir situated a few kilometres downstream of the Augrabies Falls at Blouputs, except that the RVM diversion weir will have the offtake structure attached on the right bank of the river. The Blouputs weir is illustrated in Plate 3.2.

Plate 3.2: Blouputs hydrological gauging weir, Orange River, looking upstream

Construction

In order to construct the weir in the dry it will be necessary to construct a temporary water-tight coffer dam around the construction area, and keep the area dewatered by pumping until construction is complete. It will also be necessary to keep the river flowing during construction, and to avoid the need to divert the river flow into another natural or excavated channel, the construction will be undertaken in two phases, as illustrated in Figure 3.8.

It is probable that the coffer dams will need to be around 7m high to avoid overtopping by elevated flows in the river.

Some limited blasting may be required, but this will be strictly limited to within the confines of the cofferdams.

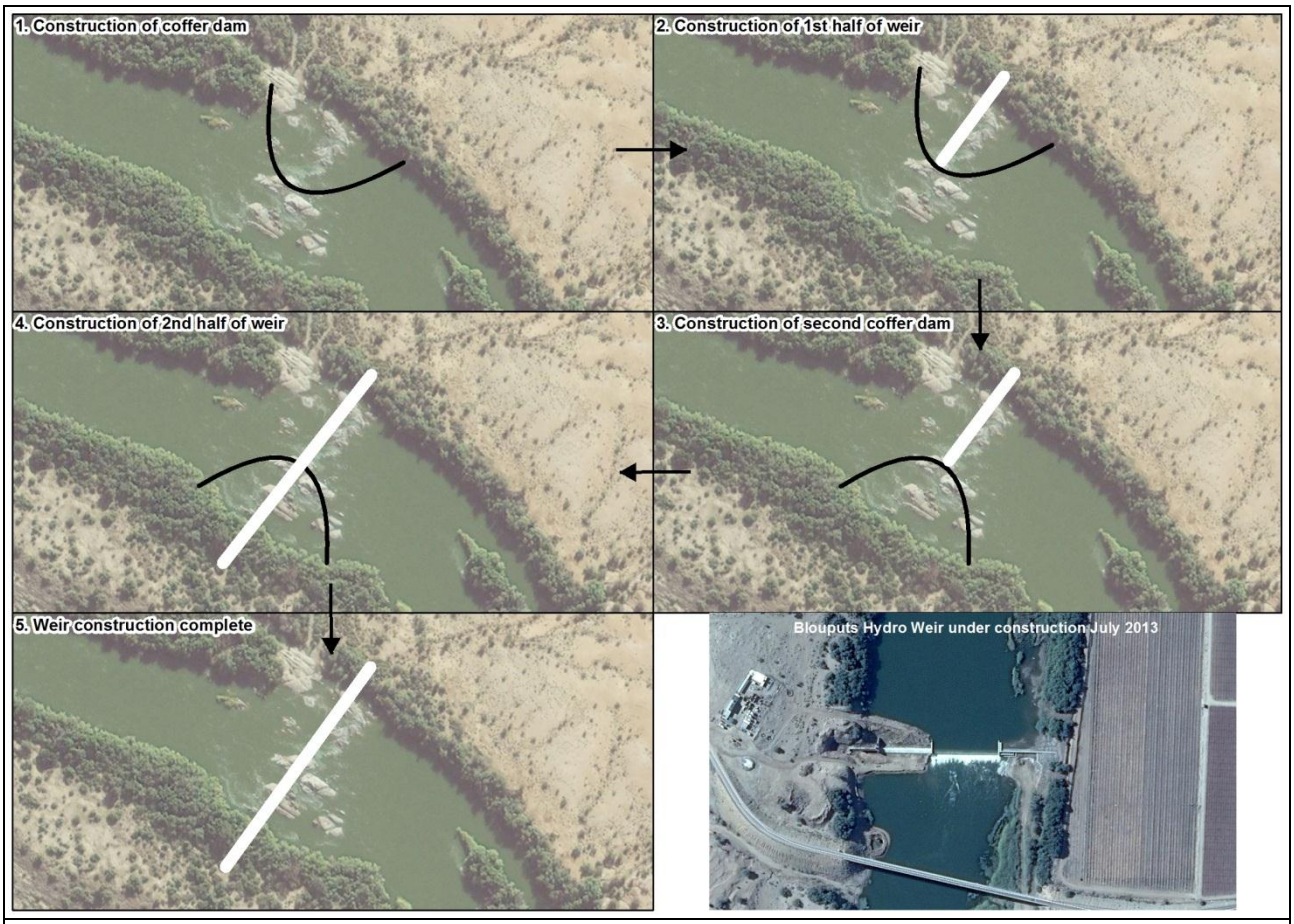


Figure 3.8: Stages in the construction of the diversion weir

The bottom tight-hand frame shows a Google Earth™ image of the construction of the Blouputs hydrological gauging weir nearing completion in July 2013.WE. The cofferdam is visible on the left had side of the weir.

3.2.2 Offtake structure

Location

The offtake structure will be constructed at the end of the weir on the right bank of the river.

Purpose

Its purpose is to channel water diverted by the weir into the headrace.

Design

The offtake will be constructed in reinforced concrete, and will be an L-shaped box-like structure approximately 30m by 30m on plan (see Figure 3.9), with a maximum height about 8.5m above the water level at the weir. The height is necessary to accommodate the lifting mechanism for the two radial gates (Figure 3.9) that will control the volume of water allowed into the two rectangular culverts that will comprise the headrace. The purpose of the radial gates is to regulate the volume of water entering the headrace so that the minimum flow passing over the weir is maintained when the river flow is low, and also to ensure that only the volume of water required for electricity generation is transferred into the headrace when the river flow is high.

The structure will include reinforced concrete vertical steel trash racks upstream of the radial gates to prevent floating debris such as tree branches and reeds from entering the headrace.

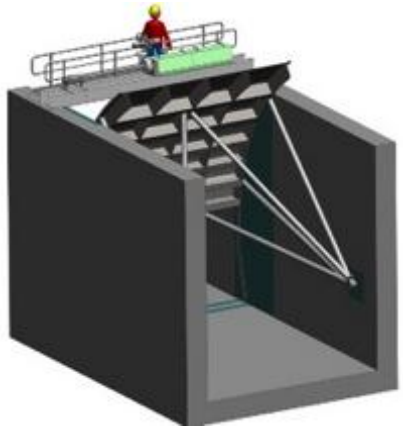


Figure 3.9: Artist's impression of the offtake structure, and radial gate in a rectangular channel

Sources: Hydro Tasmania South Africa SA & https://www.google.co.za/search?q=radial+gates

Construction

The structure will be cast *in situ* reinforced concrete, and will be constructed in the cofferdam for the right side of the weir. It is probable that some blasting will be required for the foundations of the structure, but this will be strictly limited to the confines of the cofferdam.

3.2.3 Headrace

Location

The headrace will run from the offtake structure at the diversion weir to the headpond by the power chamber, and will be approximately 4.6km long (see Figure 3.2).

Purpose

The purpose of the headrace is to convey water at a controlled flow rate from the Orange River to the power chamber.

Design

The headrace will comprise two rectangular box culverts laid side by side in a trench of sufficient depth so that the headrace is completely underground for its entire length. Each of the culverts will be 3.6m wide by 3.3m deep, and they will flow partially full by gravity at a shallow gradient (Figure 3.10).

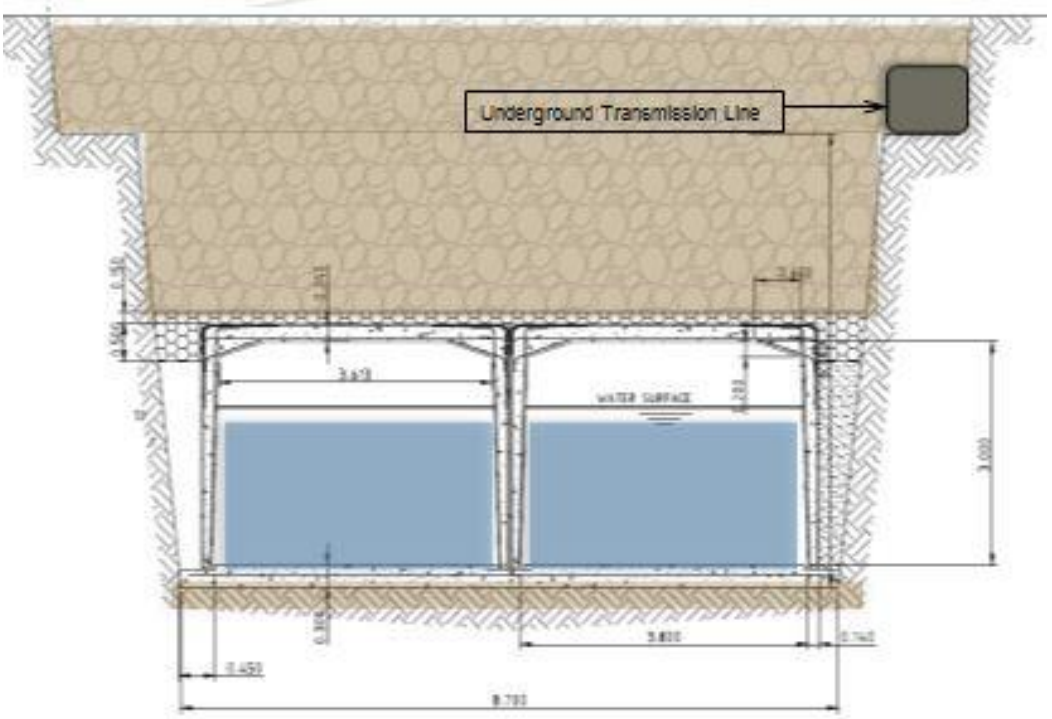


Figure 3.10: Typical cross section through the headrace culverts

Source: Hydro Tasmania South Africa

Recent seismic activity has been recorded in the Augrabies area, in the form of an earthquake swarm consisting of continual small seismic tremors. The swarm started in July 2010 and included 16 events with magnitude of between 4.0 and 5.0 (Richter scale) up to December 2014 (Stapelberg 2015). Accordingly the reinforcement detailing will follow good practice for earthquake resistance as detailed in SANS 10160-4:2011 (Basis of Structural Design and Actions for Buildings and Industrial Structures — Part 4: Seismic Actions and General Requirements for Building). The culverts will be bedded on sand and backfilled with a granular material won from the excavation, and joints between sections of culvert will be flexible to allow for movement.

Construction

The excavation for the culverts may be up to 14m wide, depending on the depth of cover, and the trench will be backfilled and rehabilitated once construction is complete. The trench will be extended on the northern side to accommodate the power lines necessary to evacuate the power generated to the national grid.

It is probable that the excavation of the trench will require some blasting, and this will be undertaken under strict conditions according to a detailed protocol developed between the developer and the civil engineering contractor to ensure safety and to minimise disturbance in sensitive areas.

The culverts will be cast *in situ* or in precast concrete.

3.2.4 Headpond and forebay

Location

The headpond and forebay – the intake to the penstocks – is located at the downstream end of the headrace, immediately upstream of and adjacent to the site of the power chamber (see Figures 3.2 and 3.11).

Purpose

The headpond regulates flow into the turbines in the power chamber, and also protects the headrace water conduit from surges caused by machines shutting down, or drainage of the water conduit due to machines starting up.

Design

The headpond will be situated in a shallow and gently sloping depression, and the impoundment will be closed by an earthen embankment up to about 3m high, with a crest length of about 160m at the lower end of the depression. The surface area of the headpond at full supply level will be about 12 000 square metres. The headpond may be lined by a waterproof membrane, grouting of fissures or by concrete lining.

Plate 3.3: General view of headpond site looking towards the site of the embankment

Depending on the outcome of sedimentation studies in the Orange River it may be necessary to construct a sediment settling basin at the downstream end of the headrace within the headpond. Large particles of sediment in the water can damage the turbines, and the settling basin will remove the sediment, after which it will be conveyed through the powerhouse and discharged into the tailrace tunnel. Should sediment trapping and removal be required this will be constructed as part of the headpond and not as a separate structure.

A spillway will be necessary to deal with the volume of water flowing into the headpond from the tailrace between rapid closures of the penstock intake gates during emergency turbine shutdowns and the closure of the radial control gates at the offtake at the diversion weir. In normal operation these events are anticipated to be relatively infrequent and the excess volumes of water relatively small. The spillway will discharge into the head of the gorge into which the turbine tailrace will discharge.

Construction

Excavation at the site will be limited to clearing the base for the embankment sufficient to ensure its water tightness, and to provide sufficient depth in the forebay over the entrance to the penstock to prevent the formation of vortexes into the penstock. Some blasting may be required.

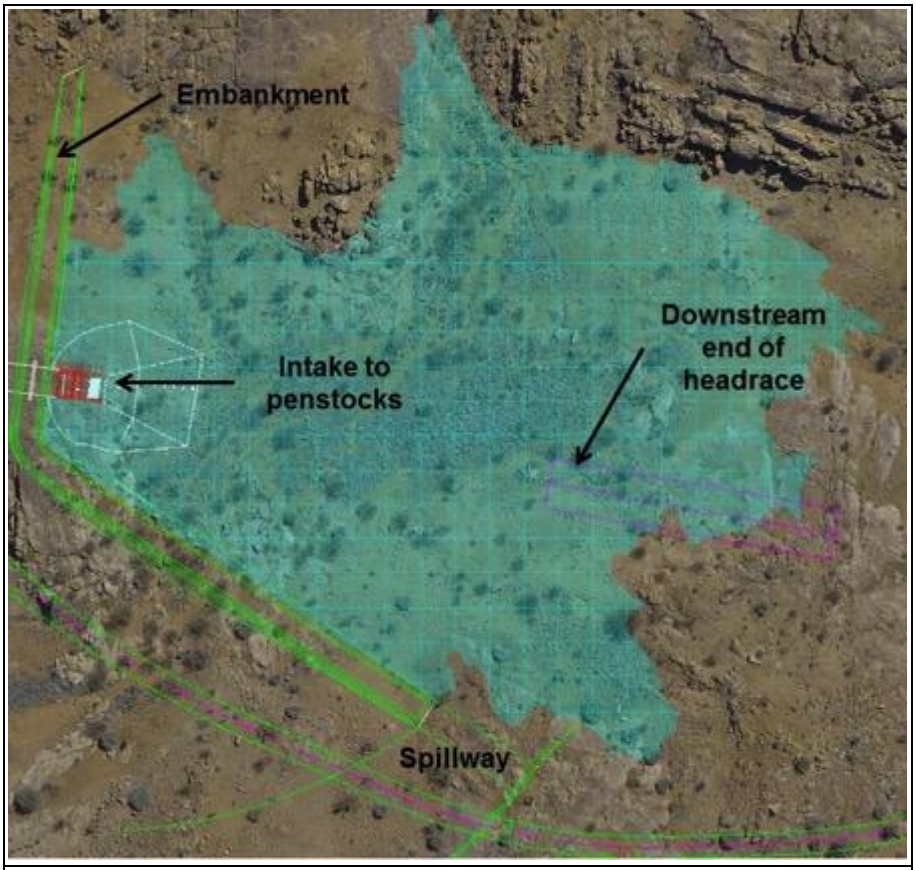


Figure 3.11: General layout of headpond and forebay

3.2.5 Penstock

Purpose

The penstock carries water from the headpond at high velocity direct to the turbines.

Design

The penstock will be a 3.4m diameter pipe, most probably in steel, that exits the headpond horizontally, and after a short distance turns vertically through 90 degrees into a 120m deep, 6m diameter vertical (or near vertical) shaft down to the power chamber. The flow in the penstock is split among the four turbines by means of a pipe manifold immediately upstream of the turbines.

Construction

Construction of the penstock shaft, power chamber and tailrace outfall is dealt with in section 3.3.7.

3.2.6 Power chamber

Location

The power chamber is located approximately 120m below the headpond.

Purpose

The purpose of the power chamber is to contain four 10MW Francis turbines and generator sets, and other electrical infrastructure necessary to generate electricity.

Design

The chamber will be an underground cavern approximately 45m long, 30m wide and 20m high. The intention is for the chamber to be unlined, but this will depend on the quality of the rock, and

some reinforcement such as rock bolting and sprayed concrete may be necessary to ensure the structural integrity of the chamber. The design will also accommodate seismic activity in the area.

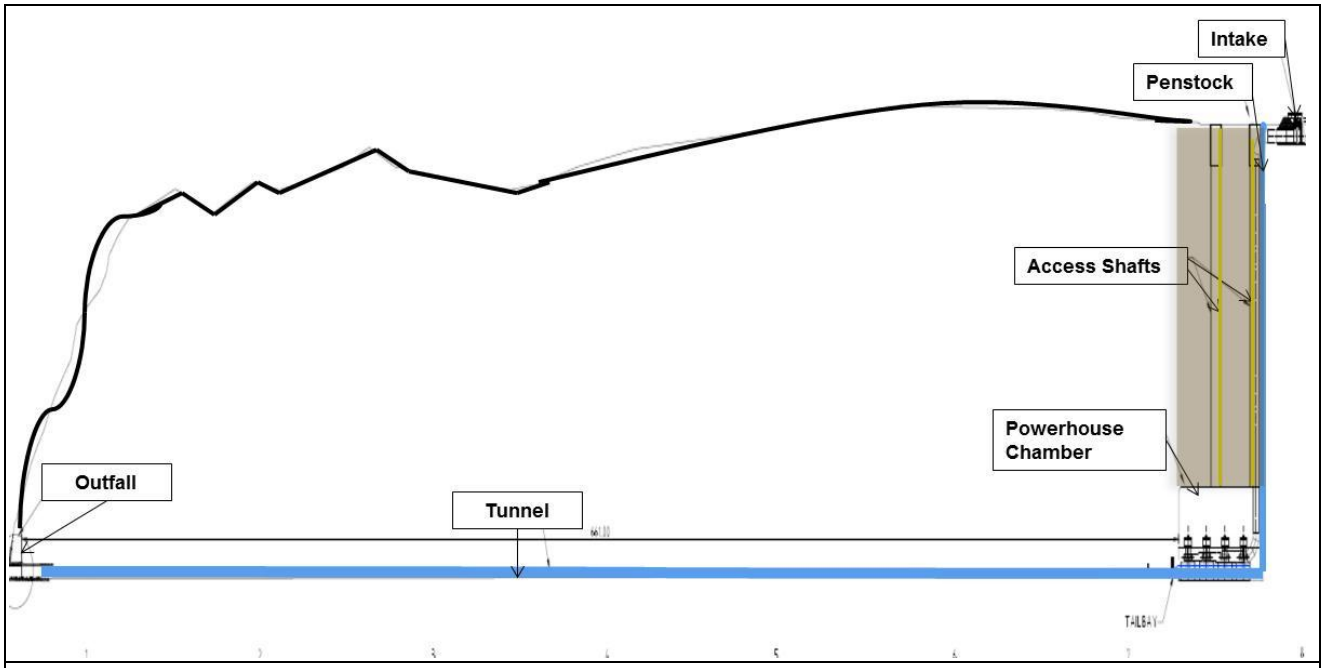


Figure 3.12: Schematic longitudinal section through penstock shaft, power chamber and tailrace

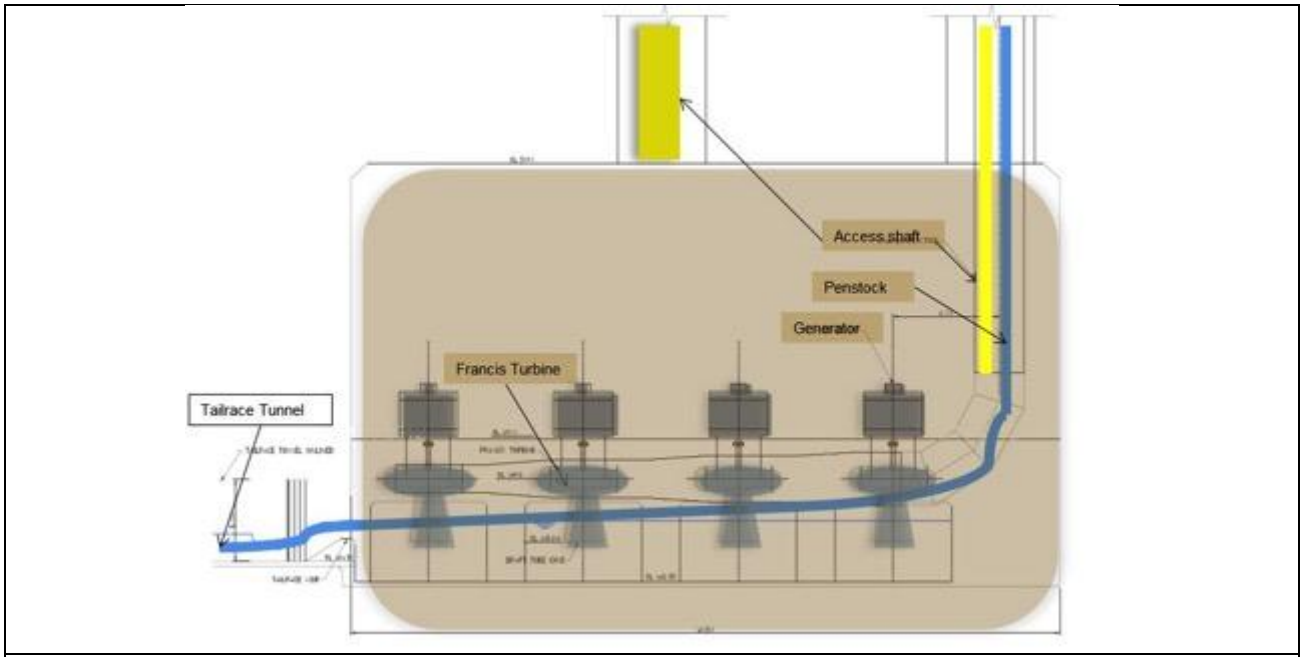


Figure 3.13: Schematic of power chamber

Source: Hydro Tasmania South Africa

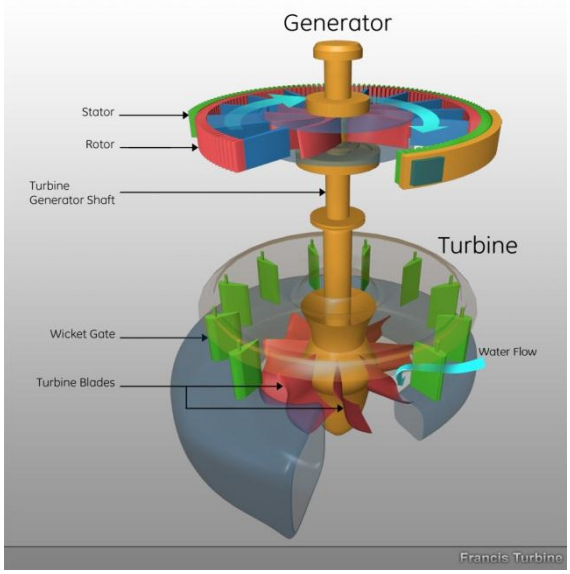


Figure 3.14: Power chamber and schematic of vertical spindle Francis turbine and generator set

Sources: https://www.google.co.za/search?q=underground+hydropower+stations and https://www.google.co.za/search?q=francis+turbine

Construction

Construction of the penstock shaft, power chamber and tailrace outfall is dealt with in section 3.3.7.

3.2.7 Tailrace

Location

The tailrace joins the underground power chamber with a normally dry channel of the Orange River. Under normal flow conditions the channel, referred to locally as the dry falls, does not carry flowing water. It is, however, evident that at high flow rates in the mainstem river water backs up into the channel, and these episodes serve to refresh aquatic fauna and the riparian and in-channel vegetation. During large flood events it is probable that water flows into the upper end of the channel from the north-bank secondary channels upstream of the Augrabies Falls, and that water flows along the channel.

The photograph in Plate 3.4 is taken from a point on the edge of the gorge above the location of the tailrace outfall. The Orange River mainstem channel is about 2.2km downstream, around the left hand bend visible in the frame. Note the riparian and in-channel vegetation on the floor of the gorge.

Plate 3.4: The dry gorge – the receiving channel for tailrace outfall

Purpose

The purpose of the tailrace is to carry the water from the turbines back into the river.

Design

The tailrace is designed as a horseshoe-shaped tunnel of nominal diameter 6m. If rock conditions are suitable the tunnel will be unlined. The tunnel will be 675m long. Erosion protection, probably in the form of large boulders used as stream breakers, will be provided at the outfall point to limit erosion in the receiving channel.

Construction

The tailrace, power chamber and penstock shaft will be constructed approximately as follows:

(i) An access / haul road will be constructed from the head pond area to the location of the tailrace outfall.
Possible routes for the haul road into the dry gorge are shown on Figure 3.15.

(ii) The tailrace tunnel is excavated from the downstream end to the furthest limits of the power chamber, and the chamber is hollowed out.
It is anticipated that the tunnel and power chamber will be excavated using conventional drill-and-blast technology.

(iii) The penstock shaft, together with ventilation and services shafts will either be excavated upwards to the ground surface, or drilled and blasted down from the surface.

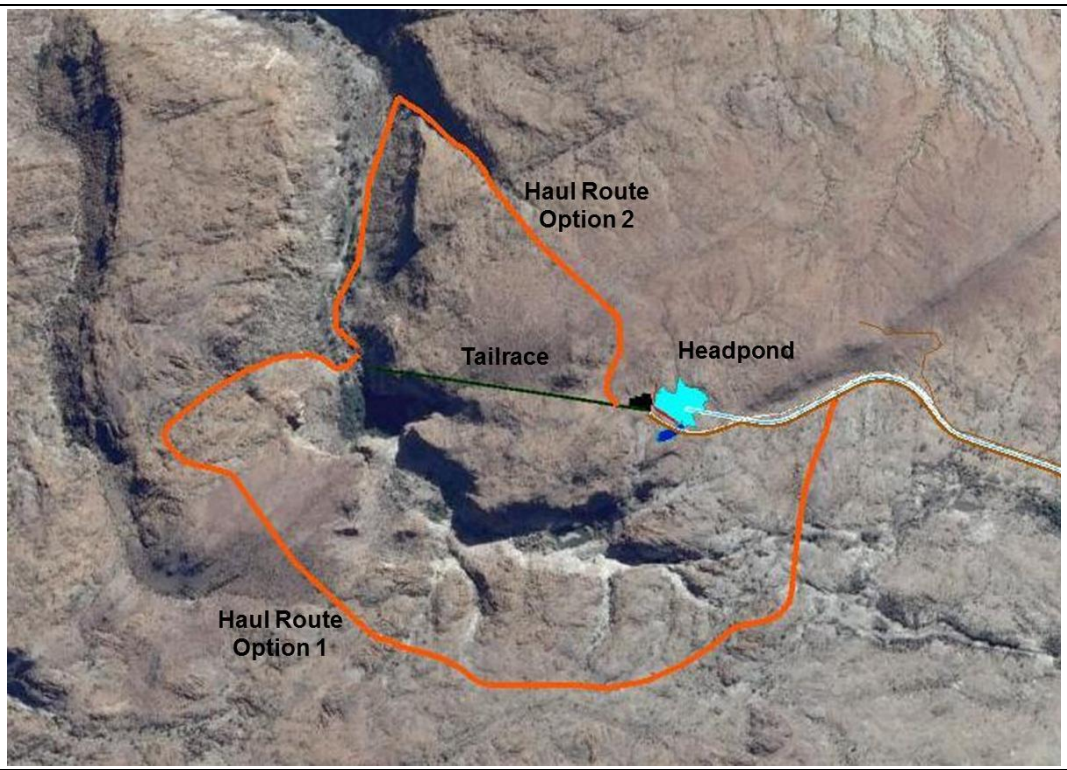


Figure 3.15: Possible routes for haul roads into the dry gorge

The southern route, although longer, is preferred because the gradients into the gorge are relatively mild, and there is also more space in the gully at the dry gorge end of the route to establish a construction yard / lay down area. The option has the disadvantage that it must cross the channel to access the tailrace outfall point.

The northern route is much shorter, but the gradients in the gulley into the gorge are quite severe, and considerable benching will be needed along the bottom of the gorge to traverse the scree slopes.

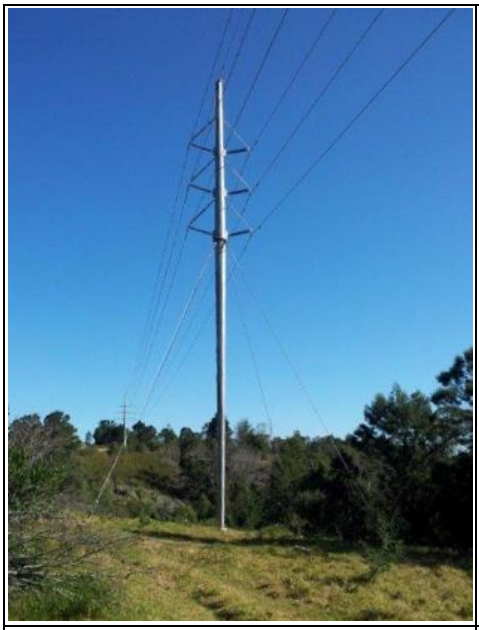
3.2.8 High voltage distribution infrastructure

Power will be evacuated via a 33kV underground transmission line across Farms 498/1 and Rem 497 (see Figure 3.2). From the powerhouse to the substation is a distance of approximately 7.5 km. Once beyond the boundary of Farm Rem 497 the voltage is stepped up to 132kv via a new substation / transformer and becomes an overhead line for the remainder of the route to a point on the far side of the river where it connects to the existing Eskom Renosterkop – Blouputs line. This arrangement has not yet been formally approved by Eskom, but the route was developed in conjunction with and with the agreement of Eskom staff.

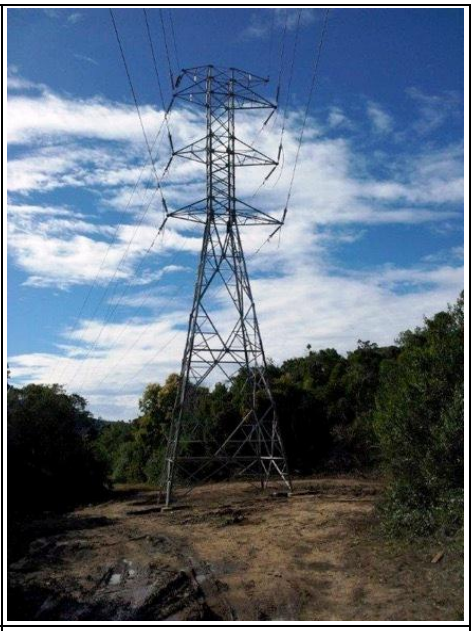
The transmission line will cross the multiple channels of the Orange River via single spans, with un-stayed monopoles located outside the riparian zones, as discussed with Eskom (see Plate 3.5).

In addition to un-stayed monopoles illustrated in Plate 3.5 there are a number of other possibilities for the support structures for the remainder of the above-ground sections of the transmission line. At this stage it is estimated that about 20 support structures will be required, and the most appropriate structure will be discussed with and agreed with Eskom. Candidate structures are illustrated in Plate 3.6.

Plate 3.5: Transmission line crossing of the Orange River at Neusberg

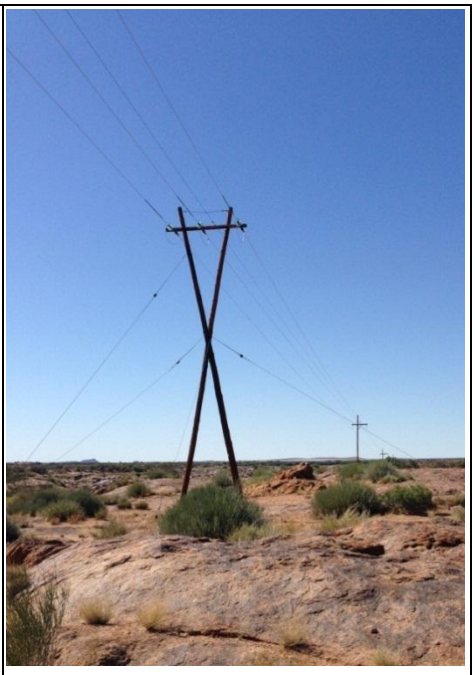


Cable-stayed monopole



Lattice

Multiple timber poles in an urban setting



Stayed and un-stayed timber poles in the Augrabies Falls National Park

Plate 3.6: Types of transmission line support structures

3.2.9 Excavated material

The project will generate surplus excavated material – spoil - a significant proportion of which is expected to be rock, particularly from the underground works (shafts, power chamber, and tailrace). It is anticipated that much of the material, after appropriate processing, will be suitable for the construction of access and haul roads, and some of the material will be used as backfill. Estimated volumes for all elements of infrastructure are as follows:

Total volume of excavation:	323 000 m^3
Volume of material for access roads:	83 000 m^3
Volume of backfill:	140 000 m^3
Balance for disposal:	100 000 m^3

A site for disposal of approximately 100 000 cubic metres of spoil has been tentatively identified at a location close to the proposed new substation at the northern end of the above-ground transmission line across the Orange River (see Figure 3.5). The area of the spoil site will be approximately 55ha, and the material will be deposited and shaped to conform to the general topography so as to minimise the visual impact, and also to minimise the impacts on vegetation and the natural drainage lines towards the Orange River. It is possible that the volume of spoil to be disposed of may be reduced by making suitable material available for use as building material to the members of the Riemvasmaak community.

If on site disposal of surplus excavated material is required (that is, a licensed waste facility cannot be located at which to dispose of the material), it will be necessary to apply for a Waste Management Licence in terms of Regulations made in 2013 under the NEM: Waste Act, 59 of 2008. The material is defined as inert material, and the nature of the impact assessment required will depend on the volume of material to be disposed of.

3.2.10 Temporary infrastructure

A temporary site office will be required to accommodate professional, technical, engineering, supervisory and administrative staff for the duration of construction. The offices will require water and electricity supplies, and an appropriate on-site package sanitation system. A suitable site for

the office will be identified in conjunction with the contractor.

It is anticipated that three site camps will be required, one to service the construction of the diversion weir and offtake structure, one to service the construction of the tailrace, and for the head pond, powerhouse and tailrace. Suitable locations for these camps have not yet been identified in detail. The size of the camps will be of the order of 50m x 75m, and will provide space to store materials and plant, small satellite staff offices, canteens and ablution facilities for staff.

The construction workforce is estimated to be 150 to 200 people at the peak of construction. All staff and workers will be accommodated in the Kakamas / Augrabies area, and there will be no residential accommodation on site.

3.2.11 Estimated size of physical footprint

Table 3.1: Estimated size of infrastructure

Element of Infrastructure	Estimated Plan Area (m^2)	Remarks
Diversion weir	800	Permanent; above ground but mostly submerged
Offtake Structure	700	Permanent; above ground
Headrace (includes buried power lines)	37 000	Permanent; underground
Headpond, forebay and overflow	12 000	Permanent: above ground: mostly a water surface
Power station headworks & transformer yard	500	Permanent ; above ground
Power chamber	450	Permanent; underground
Tailrace	3 500	Permanent; underground
Substation	6 000	Permanent; above ground
Access / haul roads	45 000	Includes existing tracks; permanent; above ground
Power lines	200	Max 20 support structures; permanent; above ground
Construction yards and site offices	35 000	Temporary; above ground
Surplus spoil storage	500 000	Total site area; temporary; above ground
Soil storage	2 500	Temporary; above ground
Summary		
Permanent, above ground	65 200	m^2
Permanent, underground	40 950	m^2
Temporary above ground	537 500	m^2

3.3 Considerations for the Diversion Weir

3.3.1 Flow division

No water will be diverted from the Orange River into the HPP headrace while the flow rate in the river is less than or equal to 30m³/s, which is the flow rate quoted by DWS as the target minimum flow rate at Neusberg Weir. An analysis of previous EWR recommendations is set out in the next section

Diversion of water into the headrace will commence when the flow rate in the river exceeds 30m³/s, and the rate of diversion will increase progressively until the flow rate approaching the weir

reaches 90m³/s, at which time the diverted flow rate will be at its maximum of 38m³/s, with 52m³/s flowing over the weir to the Augrabies Falls. This means that, at a total flow rate of 90m^3/sec in the river, 42% of the flow in the river will be diverted into the project headrace to generate electricity, and 58% will continue over the weir to the Augrabies Falls. This is the largest proportion of the total river flow that will be diverted into the headrace. When the flow rate in the river exceeds 90m³/s the radial gates at the upstream ends of the headrace culverts in the offtake structure will be used to regulate discharge into the headrace so that it never exceeds the design discharge of 38m³/s. The proportion of total river flow diverted into the headrace decreases progressively as the flow rate in the river increases: when the river is flowing at 200m³/s of the proportion of total flow diverted into the headrace will be 19%, for instance, which will decrease to 9.5% when the river is flowing at 400m³/s, and so on. In case of power failure at the offtake structure or machine shut-down in the power house the radial gates will be lowered completely to prevent flow entering the headrace.

The flow duration curves[4] in Figure 3.17 compare the flow rate over the falls before and after implementation of the proposed RVM HPP for an average hydrological year. The curves show that:

- For ±20% of the time no flow will be diverted into the tailrace:
  - For ±15% of the time (55 days) the river flows at or less than 30m³/s, so no flow will be diverted into the headrace and the HPP will not operate.
  - For ±5% of the time (18 days) the river flows at more than 800m³/s. At this flow rate it is anticipated that the sediment loads in the river will begin to increase to such an extent that sediment could be drawn into the headrace, and could result in damage to the turbines. It is anticipated that no flow will be diverted into the headrace beyond this flow rate; and that power generation will be shut down to prevent damage to the turbines. It is, however, important to note that this upper limit for flow diversion will be verified by further detailed design work, and
- For ±45% of the time (165 days, or 5.4 months) river flows are between 30m³/s and 90m³/s, diverted flow will progressively increase from zero to 38m³/s, and the power station will operate at less than its installed generating capacity.
- For ±35% of the time (128 days, or 4.2 months river flows exceed 90m³/s but are less than 800m³/s, diverted flow will be at a maximum of 38m³/s, and the power station will operate at its full design capacity

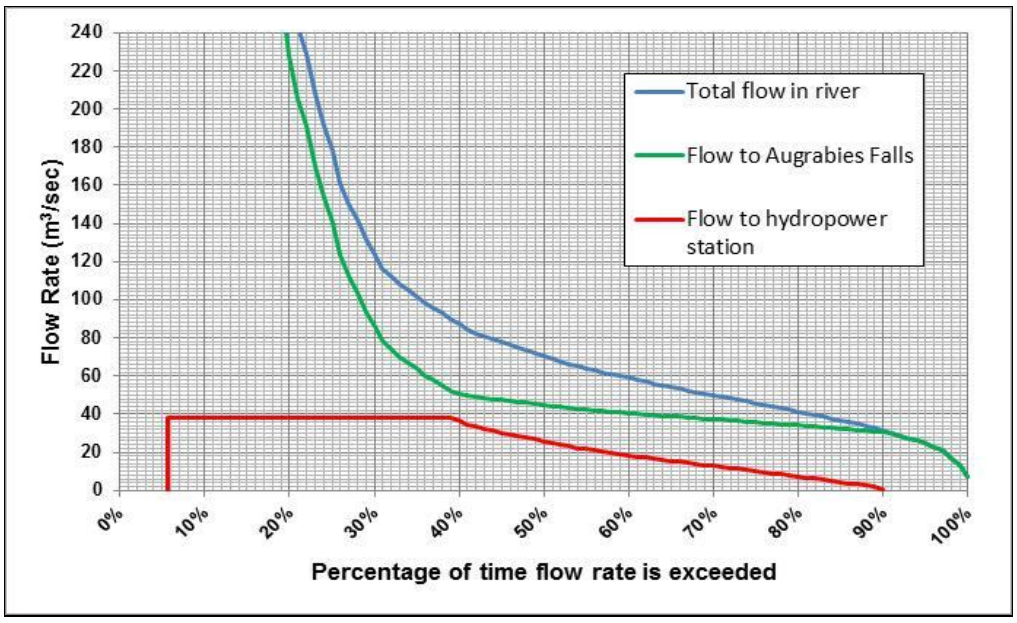


Figure 3.17: Flow duration curves illustrating the impact of the HPP on flow in the river

[4] A flow duration curve is a graphical plot that shows the percentage of time that the volumetric flow rate in a river or stream is likely to equal or exceed some specified value.

3.3.2 Previous environmental water requirements recommendations

Environmental water requirements (EWR), also referred to as environmental flow requirements (EFR), instream flow requirements (IFR) and, in the National Water Act, the ecological Reserve, are the volumes of water required in a river to maintain its ecosystem functioning. The results of three previous studies are analysed to determine the validity of the flow rate in the river of 30 m^3/sec as the threshold at which the hydropower project will start to divert water from the river, and below which no water will be diverted.

ORASECOM 2007a

WRP Consulting Engineers et al, in reviewing the surface water hydrology of the Orange River Catchment, estimated that the natural mean annual runoff (nMAR) of the Orange River at the mouth at Alexander Bay / Oranjemund is about 11 600 million cubic metres per annum (Mm3/a), of which about 10 700 Mm3/a originate from catchments in Lesotho and South Africa, upstream of the Augrabies Falls. Table 1-1 of the report - *Orange River Water Balance at 2005 Development Level* – sets out estimates of the water requirements in the catchment, and includes 900 Mm^3/a as the Environmental Requirement, which figure includes natural evaporation losses from the Orange River (that is, from the (water surface of the river). 900 Mm^3/a is equivalent to a constant, year-long flow rate of 24.8 m^3/sec.

ORASECOM 2007b

WRP Consulting Engineers *et al*, in ORASECOM 2007b, quote the same figure of 900 mm3/a as the Environmental requirements of the river, but also tabulate (in Table 3-7) the monthly volumes of water currently released (that is, in hydrological year 2005/06) from upstream impoundments to meet environmental and instream flow requirements at the river mouth, as shown in Table 3.2.

Table 3.2: Orange River Mouth Environmental plus IFR (released from upstream impoundments)

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Volume	32.14	31.10	32.14	32.14	29.29	32.14	31.10	24.11	15.55	9.37	9.37	10.37	**288.82**
Flow rate	12.0	12.0	12.0	12.0	12.1	12.0	12.0	9.0	6.0	3.5	3.5	4.0	**Av 9.2**

Source: ORASECOM 2007b, Table 307

Notes:
(i) All volumes are in millions of cubic metres.
(ii) Average monthly flow rates are calculated from the monthly volumes, and are in in cubic metres per second.

The annual volume released is significantly less than the 900 Mm^3/a environmental requirements quoted previously in the report, but this larger volume could refer to the volume of water released, from upstream impoundments, whilst the lower figure quoted in Table 3.2 above could refer to what arrives at the mouth after allowing for the estimated evaporation losses from the river between Gariep Dam and the river mouth of around 690 Mm^3/a.

The monthly volumes indicate some attempt to mimic the seasonal variation in flows. The annual average flow rate is 9.2 m^3/sec, and the average monthly flow rates vary from 3.5 m^3/sec (38% of average) to 12 m^3/sec (130% of average).

Since under normal circumstances there is negligible surface water inflow to the river between Augrabies and the river mouth the estimates in these two reports can reasonably be supposed to apply at the Augrabies Falls.

ORASECOM 2010

The report presents the results of an assessment of the environmental flow requirements (EFR) for the length of the river from Hopetown to Molopo. The present ecological status (PES) was assessed as Category C for the reach of river between Boegoeberg and Augrabies. This is relevant to this project, and the PES Category C was also the conclusion reached by the aquatic

specialist for the section of river around the diversion weir. Results are also presented for a recommended ecological category (REC) of Category B. The results are reproduced in Table 3.3.

Table 3.3: Environmental Flow Requirements Boegoeberg to Augrabies

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Present Ecological Status (PES), Category C – Maintenance Flow (m^3/sec)												
Flow rate	21.3	26.5	28.3	32.8	41.9	40.7	36.8	28.6	23.4	19.7	18.9	19.1
Annual Volume of Maintenance Flow: 886 Mm^3 (8.43% of nMAR) Volume of High Flows (Nov to Mar): 493 Mm^3 ((4.69% of nMAR) Total Annual Volume of Flow: 1 379 Mm^3 (13.12% of nMAR)												
Recommended Ecological Category (REC) Category B – Maintenance Flow (m^3/sec)												
Flow rate	30.6	51.0	60.6	80.1	112.7	114.2	95.3	81.8	37.7	23.8	20.3	19.4
Annual Volume of Maintenance Flow: 1 848 Mm^3 (17.6% of nMAR) Volume of High Flows (Nov to Mar): 493 Mm^3 (4.7% of nMAR) Total Annual Volume of Flow: 2 341 Mm^3 (22.3% of nMAR)												

Source: ORASECOM 2010 Tables 9.7 & 9.8

"Maintenance Flows" are essentially base flows that vary only relatively gradually over time, as they do in an unregulated river. As their name suggests they are intended to keep – maintain - the river in some specified condition. They are augmented during the wet season by short-duration "High Flows", which are simulated minor flood events that typically rise to their peaks (and decline again) in a period of a week or two. Whilst these events are not especially large in the context of the Orange River, they are significant flow events: daily average flow rates of 150 to 680 m^3/sec are recommended. These events are intended for some specific purpose in the river such as stimulating fish breeding migrations or inundating bankside vegetation for spawning and nursery areas.

The report presents the recommended annual volumes of flow as percentages of the natural mean annual runoff, and although it is not explicitly stated, this works out to be a little more than 10 500 Mm^3/a. By contrast the data used to compile the flow duration curves for the hydropower project indicate that, during the period 1994 to 2004 the annual runoff at Neusberg Weir ranged from a low of 1 065 Mm^3/a (1994/95) to a maximum 21 352 Mm^3/a (2010/11). The average annual runoff during the 20 year period was around 6 300 Mm^3/a. In this regard the PES Category C Maintenance Flow requirements recommended in ORASECOM – 886 Mm^3 - are 14.1% of the current average annual runoff, whilst the total volume required for this scenario – 1 379 Mm^3 - is 21.9% of the current average annual runoff.

Under the diversion scenario described previously the diversions to the power station will amount to about 10.4% of the current average annual runoff.

The flow regimes recommended in ORASECOM 2007b and ORASECOM 2010 are compared in Figure 3.18. The plot also shows the monthly average flow rates derived from the long-term flow record at Neusberg Weir.

Conclusion

The analysis indicates, first of all, the difficulties associated with the estimation of the environmental water requirements of a river the size of the Orange, the flow regime of which is almost entirely manipulated by a series of large impounding structures.

The estimates in ORASECOM 2010 were determined in a very comprehensive manner, and took account of the physico-chemical, geomorphological and hydrological drivers that together provide a particular habitat template; and the biological responses by fish, riparian vegetation and aquatic invertebrates that indicate the state of the river. The recommended flow regimes are a considered to be more credible than the intuitively lower numbers presented for the Orange River mouth in ORASECOM 2007a and 2007b.

The Maintenance Flow regime for the present ecological status, Category C - Moderately Modified - does not conflict with the recommendation from DWS that diversion of flow from the river into the HPP should not commence until the river is flowing at 30 m^3/sec. In this context it is important to note that diversion from the river is done progressively as the river flow rate increases from 30 to 90 m^3/sec, and that the flow rate over the falls when the diversion is at its maximum of 38 m^3/sec is 52 m^3/sec. It must also be borne in mind that maintaining any level of environmental flow regime in this highly regulated river as a whole is the responsibility of DWS. The prevailing monthly flow rates shown in purple in Figure 3.18 are averages over a 20-year period, during which there have been several large flooding events as well as periods of greatly reduced runoff. Accordingly the impression that monthly flow rates have never dropped below 30 m^3/sec is a result of the averaging process.

It is also important to understand that a constant flow rate of 30 m^3/sec is not intended to represent the entire environmental flow regime of the river, but is a minimum environmental flow rate, which must not be violated by diversions to the power station.

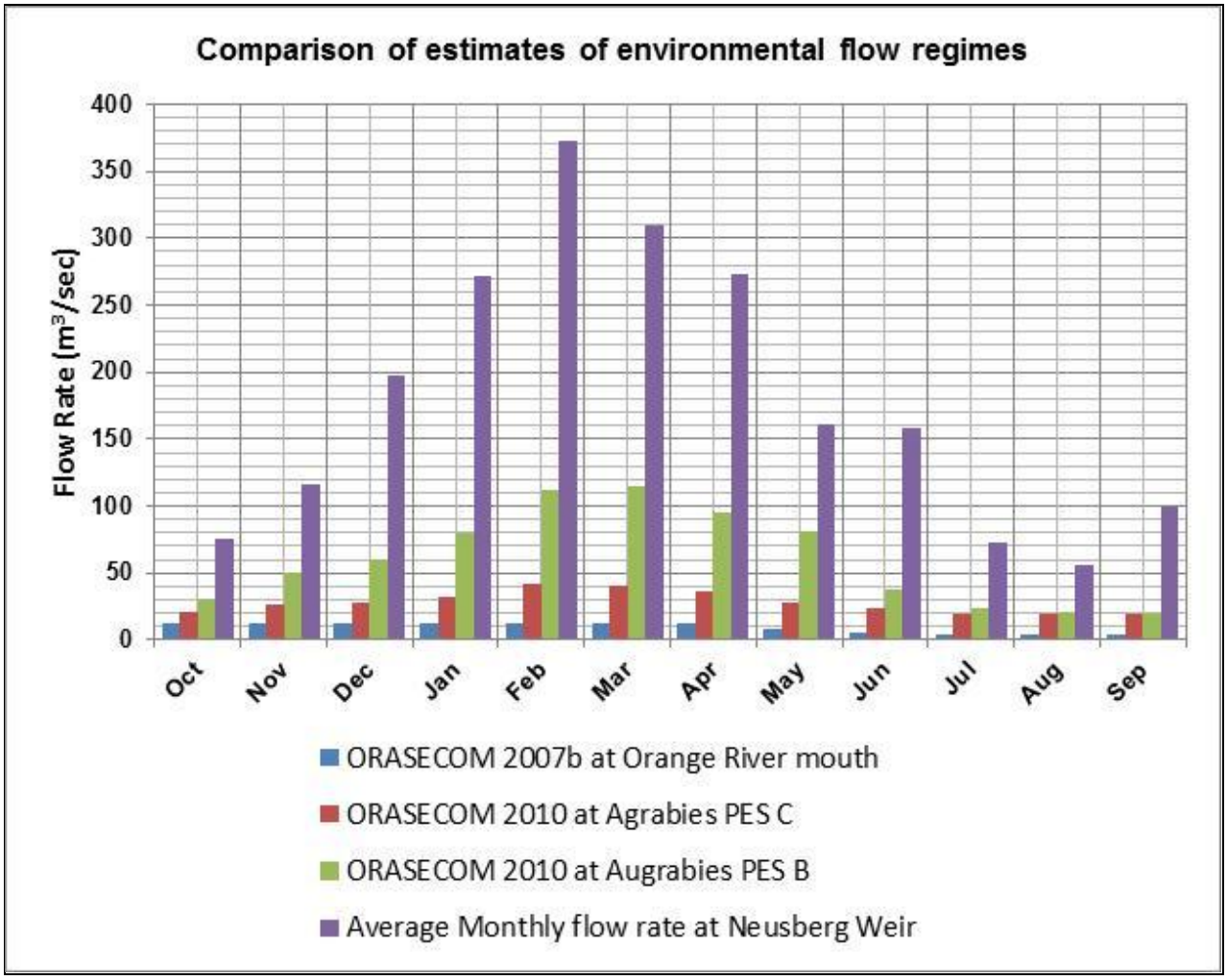


Figure 3.18: Comparison of estimates of environmental flow regimes
Notes:

(i) The ORASECOM 2007b plot displays all the data provided in the report.
(ii) The ORASECOM 2010 plots show only the Maintenance Flows.
(iii) The seasonal distribution of low used in ORASECOM 2010 is similar to that derived from the flow data
(iv) The seasonal distribution used in ORASECOM 2007b is not at all similar to the prevailing flow regime in the river, and is very much a minimum flow regime.

3.3.3 Upstream effects

An important consideration in the design of the weir is that it must not result in increases in water levels that adversely affect irrigation or drainage infrastructure on the mid-stream or floodplain farms and vineyards upstream of the weir.

The construction of the weir will raise upstream water levels, but mathematical modelling – backwater flow-profile calculations in a numerical simulation of the multiple river channels – indicates that increased water levels extend for a distance of about 3km upstream of the weir. This is known as the limit of influence of the weir. It is downstream of any cultivated areas adjacent to or between the active river channels, and indicates that the weir will not adversely affect irrigation or drainage infrastructure in these areas.

The modelling indicated that at 90m³/s river discharge water levels at the weir are raised by 800mm. As the weir becomes increasingly drowned by higher flows (that is, the downstream water level is almost equal to the upstream water level), the impact of the weir reduces, until at a flow rate of 1 000m³/s the water level at the weir is increased by only 400mm.

3.3.4 Downstream Effects of the HPP

As explained in section 3.3.1, the diversion of water from the Orange River into the HPP will reduce the flow rate in the reach of river between the diversion weir and the point at which the diverted returns to the mainstem channel. This reach includes about 2.4 km of braided channel between the weir and the falls, the falls, and the gorge downstream of the falls - a total distance of about 10km.

Since the power station does not consume the water, but only uses it to drive the turbines and generator sets, the same volume of water is returned to the river as was diverted. This means that water users downstream of the point at which the diverted water is returned to the river are not affected by the diversion.

There are no extractive users in the reach affected by the project, so no irrigation schemes will be affected. Concerns that the flow regime at the Ramsar wetland site at the river mouth may be affected are without foundation.

3.4 Emergency shutdown procedures

RVM1 Pty (Ltd) has agreed to give certain undertakings to DWS (formerly DWA) and SANParks that the operation of the HPP will be capable of being shutdown manually. The shutdown will be undertaken in accordance with a detailed protocol that will be developed jointly among all parties, and will take place under certain prescribed circumstances that could result in:

(i) Failure to allow 30m^3/sec to flow unimpeded over the weir by diverting water to the HPP when the flow is less than 30m^3/sec; or

(ii) Failure to observe the agreed progressive increase in the rate of flow diversion into the headrace from zero to 38m^3/sec as river flow increases from 30m^3/sec.

4 NEED AND DESIRABILITY ASSESSMENT

The need and desirability of the project can be demonstrated in the following main areas:

- Move to green energy due to growing concerns associated with climate change and the on-going exploitation of non-renewable resources.
- Security of electricity supply, where over the last few years, South Africa has been adversely impacted by interruptions in the supply of electricity.
- Stimulation of the green economy where there is a high potential for new business opportunities and job creation.
- The REIPPP process: the generation of renewable energy is of national importance. Nearly 3500 MW of electricity has been awarded thus far in the process, and of this amount only 18 MW is base load (hydro-electricity is base load). In April 2015 the Minister of Energy declared that she will be seeking approval for a further 6 300 MW of renewables to be procured.
- Economic analysis has shown that the project meets the likely investment hurdle rates set by equity investors and lenders in the South African market.

4.1 International

4.1.1 The 1992 United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is a framework convention which was adopted at the 1992 Rio Earth Summit. South Africa signed the UNFCCC in 1993 and ratified it in August 1997. The stated purpose of the UNFCCC is to, “achieve….stabilisation of greenhouse gas concentrations in the atmosphere at concentrations at a level that would prevent dangerous anthropogenic interference with the climate system”, and to thereby prevent human-induced climate change by reducing the production of greenhouse gases defined as, “those gaseous constituents of the atmosphere both natural and anthropogenic, that absorb and re-emit infrared radiation”.

The UNFCCC is relevant in that the proposed RVM Hydro Electric Project will contribute to a reduction in the production of greenhouse gases by providing an alternative to fossil fuel-derived electricity. South Africa has committed to reducing emissions to demonstrate its commitment to meeting international obligations.

4.1.2 The Kyoto Protocol (2002)

The Kyoto Protocol is a protocol to the UNFCCC which was initially adopted for use on 11 December 1997 in Kyoto, Japan, and which entered into force on 16 February 2005 (UNFCCC, 2009). The Kyoto Protocol is the chief instrument for tackling climate change. The major feature of the Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. This amounts to an average of 5% against 1990 levels over the five-year period 2008-2011. The major distinction between the Protocol and the Convention is that, “while the Convention encouraged industrialised countries to stabilize GHG emissions, the Protocol commits them to do so”.

The Kyoto Protocol is relevant in that the proposed RVM Hydro Electric Project will contribute to a reduction in the production of greenhouse gases by providing an alternative to fossil fuel-derived electricity, and will assist South Africa to begin demonstrating its commitment to meeting international obligations in terms of reducing its emissions.

4.2 National

4.2.1 National Development Plan (2011)

The National Development Plan (NDP) (also referred to as Vision 2030) is a detailed plan produced by the National Planning Commission in 2011 that is aimed at reducing and eliminating poverty in South Africa by 2030. The NDP represents a new approach by Government to promote

sustainable and inclusive development in South Africa, promoting a decent standard of living for all, and includes 12 key focus areas, those relevant to the current proposed project being:

- An economy that will create more jobs.
- Improving infrastructure.
- Transition to a low carbon economy (see table below).

Sector	Target
Electrical infrastructure	• The NDP states that South Africa needs an additional 29,000 MW of electricity by 2030. About 10,900 MW of existing capacity will be retired, meaning that South Africa needs to create about 40,000 MW. • About 20,000 MW of this capacity should come from renewable sources.
Transition to a low carbon economy	• Achieve the peak, plateau and decline greenhouse gas emissions trajectory by 2025. • About 20,000 MW of renewable energy capacity should be constructed by 2030.

The RVM Hydro Electric Project is in line with the NDP with regards to:

- Generating power from renewable sources;
- Creating jobs;
- Developing infrastructure;
- Transitioning to a low carbon economy.

4.2.2 National Climate Change Response White Paper (2012)

The White Paper indicates that Government regards climate change as one of the greatest threats to sustainable development in South Africa and commits the country to making a fair contribution to the global effort to achieve the stabilisation of greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system.

The White Paper also identifies various strategies in order to achieve its climate change response objectives, including:

- The prioritisation of mitigation interventions that significantly contribute to an eventual decline emission trajectory from 2036 onwards, in particular, interventions within the energy, transport and industrial sectors.
- The prioritisation of mitigation interventions that have potential positive job creation, poverty alleviation and/or positive general economic impacts. In particular, interventions that stimulate new industrial activities and those that improve the efficiency and competitive advantage of existing business and industry.

The White Paper provides numerous specific actions for various Key Mitigation Sectors including renewable energy. The following selected strategies (amongst others) must be implemented by South Africa in order to achieve its climate change response objectives:

- The prioritisation of mitigation interventions that significantly contribute to a peak, plateau and decline emission trajectory where greenhouse gas emissions peak in 2020 to 2025 at 34% and 42% respectively below a business as usual baseline, plateau to 2035 and begin declining in absolute terms from 2036 onwards, in particular, interventions within the energy, transport and industrial sectors.
- The prioritisation of mitigation interventions that have potential positive job creation, poverty alleviation and/or general economic impacts. In particular, interventions that stimulate new industrial activities and those that improve the efficiency and competitive advantage of existing business and industry.

The proposed RVM Hydro Electric Project will provide an alternative to fossil fuel-derived electricity, and will contribute to climate change mitigation.

4.2.3 White Paper on Renewable Energy Policy (2003)

The White Paper on the Renewable Energy Policy (2003) commits SA Government support for the development, demonstration and implementation of renewable energy sources for both small and large scale applications. It sets out the policy principles, goals and objectives to achieve, “An energy economy in which modern renewable energy increases its share of energy consumed and provides affordable access to energy throughout South Africa, thus contributing to sustainable development and environmental conservation”. In terms of the White Paper, the Government sets a target of 10 000 GWh renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro.

The proposed RVM Hydro Electric Project is consistent with the White Paper and the objectives therein to develop an economy in which renewable energy has a significant market share and provides affordable access to energy throughout South Africa, thus contributing to sustainable development and environmental conservation.

4.2.4 Integrated Energy Plan for the Republic of South Africa (2003)

The former Department of Minerals and Energy (DME) commissioned the Integrated Energy Plan (IEP) in response to the requirements of the National Energy Policy in order to provide a framework by which specific energy policies, development decisions and energy supply trade-offs could be made on a project-by-project basis. The framework is intended to create a balance between energy demand and resource availability so as to provide low cost electricity for social and economic development, while taking into account health, safety and environmental parameters.

In addition to the above, the IEP recognised the following:-

- South Africa is likely to be reliant on coal for at least the next 20 years as the predominant source of energy.
- New electricity generation will remain predominantly coal based but with the potential for hydro, natural gas, renewables and nuclear capacity.
- Need to diversify energy supply through increased use of natural gas and new and renewable energies.
- The promotion of the use of energy efficiency management and technologies.
- The need to ensure environmental considerations in energy supply, transformation and end use.
- The promotion of universal access to clean and affordable energy, with the emphasis on household energy supply being coordinated with provincial and local integrated development programmes.
- The need to introduce policy, legislation and regulations for the promotion of renewable energy and energy efficiency measures and the mandatory provision of energy data.
- The need to undertake integrated energy planning on an on-going basis.

The proposed RVM Hydro Electric Project is in line with the IEP with regards to diversification of energy supply and the promotion of universal access to clean energy.

4.2.5 Integrated Resource Plan for Electricity 2010-2030

The Integrated Resource Plan (IRP2010) for South Africa was initiated by the Department of Energy (DoE) and lays the foundation for the country's energy mix up to 2030, and seeks to find an appropriate balance between the expectations of different stakeholders considering a number of key constraints and risks, including:

- Reducing carbon emissions.
- New technology uncertainties such as costs, operability and lead time to build.
- Water usage.
- Localisation and job creation.
- Southern African regional development and integration.

- Security of supply.

The Policy-Adjusted IRP includes recent developments with respect to prices and allocates 17.8GW for renewables of which 2.6 GW should come from hydro-electric power (see Figure 4.1 below):

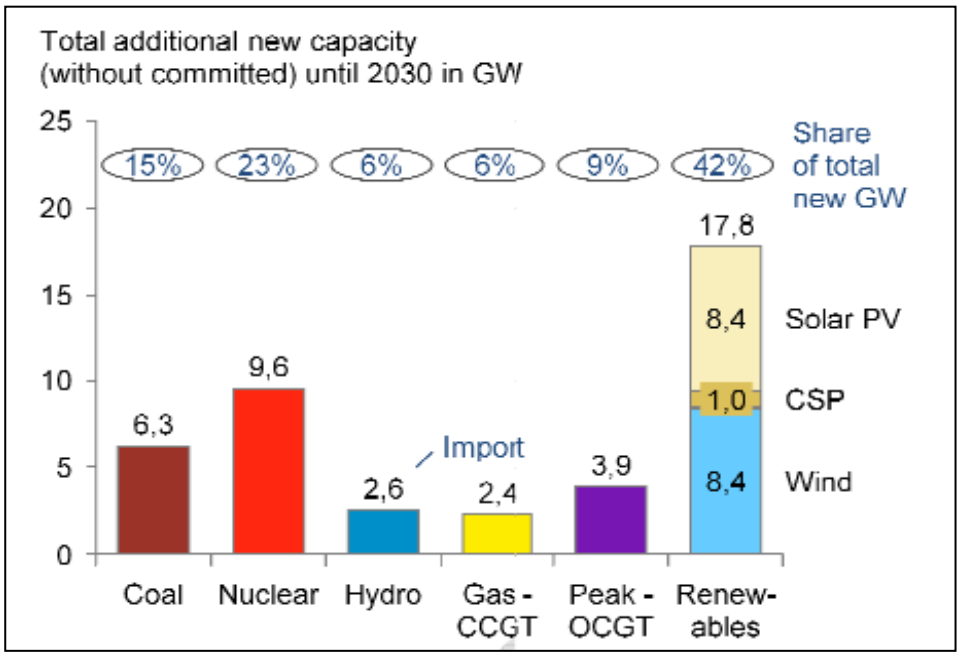


Figure 4.1: After consultation process – Policy Adjusted IRP [IRP 2010 final report rev2].

The RVM Hydro Electric project is in line with IRP2010 with regards to:

- Reducing carbon emissions;
- Job creation;
- Securing energy supply (hydroelectricity is base load).

4.2.6 Renewable Energy Independent Power Producer Procurement Programme (REIPPP)

South Africa has a high level of renewable energy potential and presently has in place a target of 10 000GWh of renewable energy. The Minister has determined that 3 725MW to be generated from renewable energy sources is required to ensure the continued uninterrupted supply of electricity. This 3 725MW is broadly in accordance with the capacity allocated to Renewable Energy generation in IRP 2010-2030.

The REIPPP Programme has been designed so as to contribute towards the target of 3 725MW and towards socio-economic and environmentally sustainable growth, and to start and stimulate the renewable industry in South Africa.

In terms of this REIPPP Programme, bidders will be required to bid on tariff and the identified socio-economic development objectives of the DoE. The tariff will be payable by the Buyer (currently Eskom) pursuant to the Power Purchase Agreement (PPA) to be entered into between the Buyer and the Project Company of a Preferred Bidder.

The generation capacity allocated to each technology is in accordance with the table below and the maximum tariff that a Bidder may bid for purposes of the IPP Procurement Programme is as set out in the RFP.

A 40 MW hydro plant connecting into the national grid Blouputs in the Northern Cape Province will have a positive impact on the stability of the South African Electricity Grid. While the small relative

size of the units will have negligible impact on the overall system frequency stability, the units will provide significant local voltage support. This voltage support is mandated in the RPP Grid code for this sort of generating unit. The voltage support improves the efficiency of the local transmission and distribution network, makes solar PV facilities less prone to interruption due to voltage dips and enhances fault detection and clearing through higher local fault levels. All these effects provide a more secure, reliable and higher quality electricity supply for customers in the region. The presence of synchronous generation in a region can also facilitate faster system restart after blackouts and assist the supply authorities in system outage management.

Renewable energy supply contracts awarded to date (May 2014)				
Technology	**Window 1 August 2011**	**Window 2 March 2012**	**Window 3 August 2013**	**Total (MW)**
Wind	634	562.5	787	**1984**
PV	631.5	417.1	435	**1484**
CSP	150	50	200	**400**
Hydro	0	14.3	0	**14**
Biomass	0	0	16	**16**
Biogas	0	0	0	**0**
Landfill	0	0	18	**18**
Total (MW)	**1415.5**	**1043.9**	**1456**	-

Source: Eberhard et al., 2014.

Technology	MW
Onshore wind	1 850 MW
Concentrated solar thermal	200 MW
Solar photovoltaic	1 450 MW
Biomass	12,5 MW
Biogas	12,5 MW
Landfill Gas	25 MW
Small hydro	75 MW
Small Projects	100 MW

Renewable energy target per the REIPPP Programme

In terms of the REIPPPP, bids would be awarded for renewable energy supply to Eskom through up to five bidding phases. The 1st, 2nd, 3rd and 4th round bidding processes have been completed where projects are currently reaching financial close in order to implement the projects. The REIPPPP is entering the 5th bidding window and the proposed RVM Hydro Electric Project will ensure that a significant portion of the REIPPPP's allocation for small hydro is filled.

4.2.7 Long Term Mitigation Scenarios (2007)

The aim of the Long-Term Mitigation Scenarios (LTMS) was to set the pathway for South Africa's long-term climate policy and will eventually inform a legislative, regulatory and fiscal package that will give effect to the policy package at a mandatory level. The overall goal is to "develop a plan of action which is economically risk-averse and internationally aligned to the world effort on climate change."

The strategy assesses various response scenarios but concludes that the only sustainable option ("the preferred option") for South Africa is the "Required by Science" scenario where the emissions

reduction targets should target a band of between -30% to -40% emission reductions from 2003 levels by 2050, which includes increasing renewable energy in the energy mix by 50% by 2050.

The RVM Hydro Electric Project is in line with the LTMS with regards to:

- Increasing South Africa's use of renewable energy sources;
- Reducing use of fossil fuels for energy generation.

4.2.8 Industrial Policy Action Plan 2011/12 – 2013/14

The South African Industrial Policy Action Plan (IPAP 2) 2011/12 – 2013/14 represents a further step in the evolution of this work and serves as an integral component of government's New Growth Path and notes that there are significant opportunities to develop new 'green' and energy-efficient industries and related services and indicates that in 2007/2008, the global market value of the 'Low-Carbon Green Sector' was estimated at £3 046 billion (or nearly US$5 trillion), a figure that is expected to rise significantly in the light of climate-change imperatives, and energy and water security imperatives.

Based on economic, social and ecological criteria, IPAP identifies a number of sub-sectors and an initial round of concrete measures proposed for development of the renewable energy sector with key action programmes.

Key Action Programmes include but are not limited to:

- Solar and Wind Energy - Stimulate demand to create significant investment in renewable energy supply and the manufacturing of local content for this supply.
- Green Industries special focus: The South African Renewables Initiative (SARi) - SARi is an intra-governmental initiative set to catalyse industrial and economic benefits from an ambitious program of renewables development; including financing and associated institutional arrangements that would not impose an unacceptable burden on South Africa's economy, public finances or citizens.

The RVM Hydro Electric Project is in line with IPAP 2 with regards to:

- Development of renewable energy.
- Electricity generation.

4.2.9 Strategic Infrastructure Projects (2012)

The National Infrastructure Plan that was adopted in 2012 together with the New Growth Path, which sets a goal of five million new jobs by 2020, identifies structural problems in the economy and points to opportunities in specific sectors and markets or "jobs drivers", which resulted in the establishment of the Presidential Infrastructure Coordinating Committee (PICC) which in turn resulted in the development of 18 Strategic Infrastructure Projects (SIPS).

The following SIP projects are relevant to the proposed project:

SIP 8: Green energy in support of the South African economy:

- Support sustainable green energy initiatives on a national scale through a diverse range of clean energy options as envisaged in the Integrated Resource Plan (IRP2010).

SIP 9: Electricity generation to support socio-economic development:

- Accelerate the construction of new electricity generation capacity in accordance with the IRP2010 to meet the needs of the economy and address historical imbalances.

The RVM Hydro Electric Project is in line SIP 8 and SIP 9:

- Development of the green economy.

4.3 Local Municipality

4.3.1 Kai !Garib Local Municipality

The municipality recognises and supports the solar and hydro electrical projects currently being undertaken in the municipality (Integrated Development Plan, June 2014). The IDP states that electricity supply to the more rural areas is a challenge.

4.3.2 Benefits to local communities

As noted previously the proposed HPP will be bid under the Department of Energy's (DoE) Renewable Energy Independent Power Producer Program (REIPPP). The minimum requirements for issues such as procurement, employment and local shareholding in the program are set out in Volume 5 - Economic Development Requirements - of the DoE's Request for Qualification and Proposals (RFP) documentation. The Applicant anticipates the following measures for this project to meet DoE's requirements.

Local Content: The procurement of South African goods and services is expected to be in the region of 75%. This is possible due to the high civils component of the project and very few imported components required for the build.

Job Creation: It is anticipated that the project will be able to provide employment for around 150 to 200 persons per month from the local community during the three-year construction period. These figures are supported by the Applicant's experience of the numbers of persons employed during the construction of the recently completed Neusberg project in Kakamas. During the operations phase of the project it will employ 7 to 10 persons for the lifetime of the facility. A well-maintained hydro facility can be expected to have a lifespan of more than of 80 years.

Community Shareholding: The RFP dictates that the local community must have between 1% and 5% shareholding in the project: this is not negotiable. This will be achieved through the establishment of a Broad-Based Community Trust, through which the income is channelled. The broader community therefore has the opportunity for long-term sustainable income as a result of the operations of the hydropower plant. Community here is defined in the RFP as all towns and settlements within a 50km radius of the facility. Shareholding is held via the Broad-Based Community Trust with dividend payments occurring bi-annually. The Broad Based Community Trust will be tasked with addressing the socio-economic needs of communities within 50 km of the project site.

Riemvasmaak Community Development Trust: This trust (RCDT), which owns the land on which the power station will be constructed, will hold its shareholding in the project via a special purpose vehicle (SPV) created by the Industrial Development Corporation (IDC), which is one of the investors in the project. At project financial close the IDC will provide its share of the equity funding for the project through its SPV – the RVM Hydro Community Trust (Pty) Ltd – on behalf of the RCDT. The SPV is set up in such a way that its shareholding will progressively change so that the RCDT will become the 100% shareholder once the debt (equity plus interest) is fully paid up. The debt is repaid from dividends received by the SPV, which pass through the RCDT during the tenure of the debt. The Trust will therefore receive income from dividends from the project throughout the operational phase. It is anticipated that the payment of dividends will commence six months after the project becomes operational.

This will provide a consistent income for the RCDT throughout the project's lifespan. The exact purposes for which this income will be used have not yet been determined, but it will be used for the upliftment of the community. The cumulative impacts of a sustained income of this nature over time could result in an improved standard of living for the entire community, improved access to services such as healthcare and education, the availability of funding for small business ventures, all of which also have spinoff benefits, which should contribute to the overall development of the community.

If, however, there are no dividends payable to the SPV then no dividend will be payable to the TCDT. It is important to note that, if there is a requirement for additional equity funding, this will be provided by the IDC, and the RCDT will not be asked to contribute. In addition, the RCDT does not provide any surety for the project, and is not at any risk if the project goes into default. This is because projects such as this are delivered through "Non-Recourse Project Finance", where there is no recourse on the equity participants if the project becomes distressed, other than the equity provided by them. The reason why the project can be funded on this basis is that the process of delivery of projects such as these are, in the Lender's opinion, so thorough that recourse is not required from the equity participants, and is passed through to the EPC contractor(s) and their designers.

Rental Income: The Riemvasmaak Community will receive rental income, since they own the land on which the proposed facility will be located.

Socio-economic and Economic Development Spend: Each successful Independent Power Producer (IPP) is obligated to spend between 1% and 2.5% of their revenue on social, educational, or healthcare causes in the community and on projects that promote enterprise development. This is a further benefit to the local community.

The entire process is monitored very strictly by the DoE's Monitoring and Evaluation Department and IPPs are required to submit monthly Construction Reports and Quarterly Economic Development Reports. IPPS that do not comply face penalties and/or termination points.

More recently Development Forums have been established. These provide a platform for IPPs in a given geographic area to interact with each other, the community trust, and local and district municipalities, and provide a means of co-ordinating the socio-economic spend and eliminating duplication of the provision of facilities such as crèches.

5 ALTERNATIVES

Legal Requirements in Respect of Alternatives

GN R.543 s1 – Interpretation
"alternatives", in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to—
(a) the property on which or location where it is proposed to undertake the activity;
(b) the type of activity to be undertaken;
(c) the design or layout of the activity;
(d) the technology to be used in the activity;
(e) the operational aspects of the activity; and
(f) the option of not implementing the activity.

GN R.543 s31 - Environmental impact assessment reports
(2) An environmental impact assessment report must contain all information that is necessary for the competent authority to consider the application and to reach a decision contemplated in regulation **35**, and must include -
(d) a description of identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity;
(i) a description and comparative assessment of all alternatives identified during the environmental impact assessment process.

(3) The EAP managing the application must provide the competent authority with detailed, written proof of an investigation as required by section 24(4)(b)(i) of the Act and motivation if no reasonable or feasible alternatives, as contemplated in subregulation**31**(2)(g), exist.

Summary:
Alternatives discussed in the EIAR must be:
- Different means of meeting the general purpose and requirements of the activity.
- Reasonable; and
- Feasible.

In this report items (a) and (b) of the definition of alternatives are referred to as Fundamental Alternatives, while Items (c), (d), (e) and (f) are referred to as Incremental Alternatives.

One of the objectives of an EIA is to investigate alternatives to the proposed project. There are two types of alternatives - Fundamental Alternatives and Incremental Alternatives. The EIA regulations define 'alternatives' as, "*different means of meeting the general purpose and requirements of the activity"* and further that these must be "*reasonable and feasible*" (section 31 (3)). These include alternatives to:

- The property on which or location where it is proposed to undertake the activity;
- The type of activity to be undertaken;
- The design or layout of the activity;
- The technology to be used in the activity; and
- The operational aspects of the activity.

5.1 Fundamental Alternatives

5.1.1 A different location

This section considers alternatives to the property on which or location where it is proposed to undertake the activity;

South Africa is a water-scarce country, with an average annual rainfall of around 60% of the world average, and an average annual renewable supply of fresh water of less than 1 000 cubic metres per head of population. Rainfall is spatially unevenly distributed across the country and, as a result, the availability of water also varies considerably from place to place. The east is relatively well-

watered, while most of the western parts of the country are too dry to support rain-fed agriculture. The development of a number of large dams, which can together store more than 60% of the mean average runoff from the country's rivers, has served not only to provide storage to provide in the dry periods, but in some cases, has provided the necessary head to drive hydroelectric power stations: Gariep and Vanderkloof dams, and the Thukela-Vaal Pumped Storage Scheme are three of the larger hydro-electric schemes currently in operation, but all depend on major constructions to provide the driving head.

In this regard only two rivers in South Africa have sufficiently consistent flow regimes to support hydroelectric power projects – the Orange and Thukela Rivers.

The flow regime of the Ash (Axle) River in the eastern Free State, on which two small hydro projects are being constructed, is not natural, as it is part of the transfer route for water from the Lesotho highlands to the Vaal River supply system.

As a result Hydro SA has investigated five locations on the Thukela, of which two have favourable environmental authorisations, but cannot be bid in the REIPPP process due to erratic hydrology.

15 sites on the lower Orange River have been investigated by HydroSA along a length of the Orange River which provides enough natural difference in elevation to enable the prospect of developing a feasible project in terms of the REIPPP. Of these 15 sites only four – Neusberg, Riemvasmaak, Boegoeberg and Ritchie (Orange) Falls are considered viable in terms of the REIPPP.

Thus there are no other viable alternatives capable of being bid in South Africa. The only other proposed HEP projects (on the Orange River) are two projects that require large impoundments (40m high dams) to be built near Douglas one of which, the 22MW Rooikat HPP, was granted Environmental Authorisation by DEA in July 2015 (see section 7.6.2 for further details of this project).

In most parts of the country, river flow is seldom sufficiently reliable to facilitate the development of viable hydropower schemes, but the flow regulating capacity provided by the Gariep and Vanderkloof dams presents opportunities to develop run-of-river schemes along the Orange River (without the need to construct large impounding reservoirs) where there are naturally occurring drops in elevation, at waterfalls or existing small dams and weirs.

These sites must not be regarded as alternative sites as the full potential of relatively limited hydro power from run-of river schemes needs to be explored and optimised. Currently, one site has been developed (Neusberg Weir) and one has a positive environmental authorisation (Boegoeberg Dam). The two remaining economically viable sites, both with natural drops in elevation, are Augrabies Falls and Ritchie (Orange) Falls: the former is the subject of this assessment, and the latter is being considered in conjunction with Nampower of Namibia.

The proposed site is ideal for run-of river hydro power generation and needs to be optimised for this purpose. In the context of run-of-river hydro power stations, there are no alternatives sites in the Orange River System that afford an economically viable opportunity. There are also very few sites elsewhere in the country that provide suitable locations for HEP projects.

5.1.2 A different type of development

An alternative must not only be reasonable and feasible, but it must also meet general purpose and requirements of the activity, so the purpose of any alternative project must be to develop renewable energy. Hydro SA (Pty) Ltd, the parent company of which RVM 1 Hydroelectric Power (Pty) Ltd is a special purpose vehicle for this project, was established with its core business to develop run-of-river hydro projects in southern Africa. Hydro SA does not develop solar or wind energy projects, and has no expertise or interest in doing so. Furthermore, wind and solar energy projects do not contribute to base load requirements, an imperative in South Africa, and, therefore,

available hydro power opportunities, which do contribute to base load requirements, need to be optimised. Accordingly there are no alternative renewable energy opportunities that contribute to base load that can be developed as an alternative to the run-of-river hydroelectric power project proposed.

5.2 Incremental Alternatives

5.2.1 Design / layout alternatives

Generation of hydroelectricity at this site, making use of the drop in elevation caused by the Augrabies Falls as the driving head, was previously the subject of Basic Environmental Assessments for two 10 MW projects, which at the time was the maximum installed capacity permitted by the Department of Energy under the REIPPP process. Subsequently the department increased the generating capacity from 10MW to 40MW, and the two Basic Assessment applications were withdrawn and replaced by a single application for a 40MW station. The changes were approved by DEA.

The site of the weir, immediately upstream of the divergence of a secondary channel from the right side of the mainstem channel of the Orange River, was considered as the optimum position for the diversion weir and the offtake works into the headrace. This is the proposed position of the diversion weir in this proposal. Any site further downstream would not only lose some of the driving head, but would also be approaching the Augrabies Falls, which would risk being visible to visitors to the park, prejudicing the visual experience of the falls. Also, water would be lost down the secondary channel (depending on the height of the weir). A downstream location would also mean that the headrace would have to cross the secondary channel, with the risk of ecological impacts on the aquatic environment. There is little advantage in terms of additional head by moving the weir further upstream, since the gradient of the river is very low in this reach, with the added disadvantage that the length of the headrace would be increased. In addition, potential weir sites are dictated by founding conditions in the river. Ideally a weir should be founded on rock to prevent underscouring.

During the Basic Assessment process three options were considered for the location of the power chambers, which also dictated the routes of the headraces to serve them. The options are illustrated in Figure 5.1, which is reproduced from Aurecon's December 2012 BA Report.

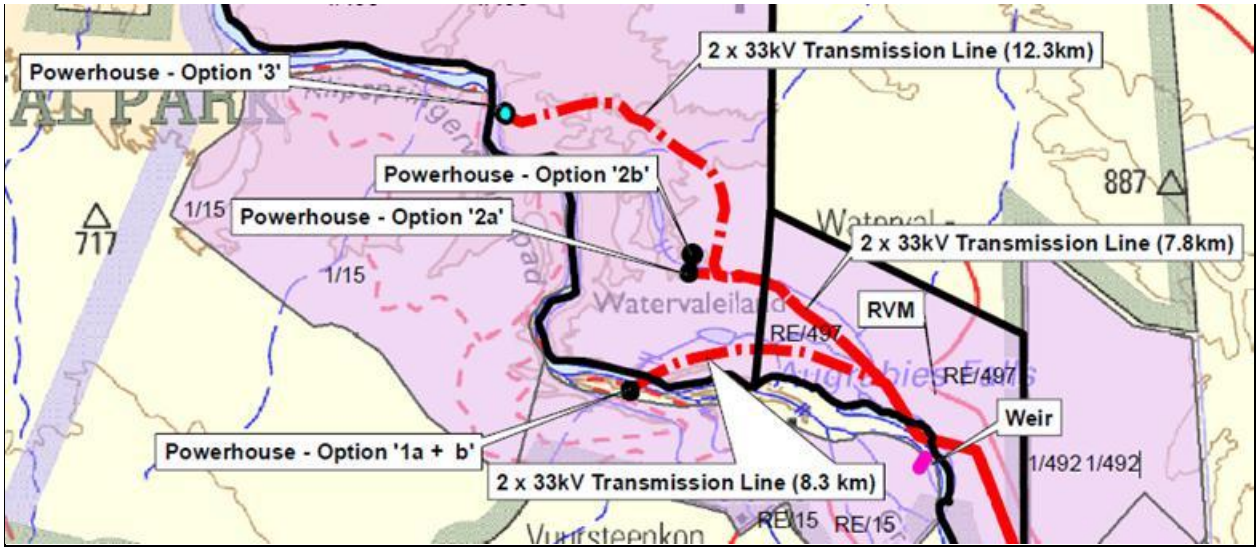


Figure 5.1: Alternative power house location and headrace route options
Source: Annexure A, Basic Assessment report, Aurecon December 2012

Options 1a & 1b involved the headrace crossing the secondary channel a short distance downstream of the diversion weir and returning flow into the Orange River a short distance

downstream of the falls. This had the disadvantage of the impacts on the secondary channel, discussed above, but also involved constructing the power chamber and tailrace outfall in a position that would probably be visible to visitors to the park. This was not considered optimal from an environmental or tourism perspective, although capital costs would have been lower.

Option 2a was the route of the tailrace, location of the head pond and power chamber, and position of the tailrace outfall that is currently proposed in this report for a 40MW station. This was preferred to the option of extending the headrace further north – previous Option 3 – and locating a power chamber a short distance from the Orange River at its junction with the Palaeo-gorge, into which it is proposed to discharge the outfall from them power chamber.

After considering the three options that were considered for the two proposed 10MW facilities, it is considered that the proposed alternative presented in this report strikes a balance between the rate of diversion of water from the Orange River to sustain an installed capacity of 40MW, the distance of infrastructure from the Augrabies Falls, the gorge downstream of the park rest camp and other facilities, and capital costs versus operational returns.

Other design considerations were as follows:

1. Access to the powerhouse – an underground decline to allow vehicular access to the powerhouse and eliminate the need for a haul road to the tailrace – excessive capital cost.
2. Access to the tailrace – a funicular "haulageway" was considered, but the amount of spoil to be removed is too great for the haulageway to be effective. The advantage is that the haul road would not be needed. Helicopters may have been needed to construct the haulageway.
3. Transmission – overhead lines were considered directly from the powerhouse to the Blouputs substation. This is the cheapest alternative and is Eskom's preferred arrangement, but would require constructing an overhead transmission line through the Riemvasmaak and the adjacent AFNP land, which would be visually intrusive.
4. Different weir crest profiles have been considered. The "crump weir" profile has been adopted as it is considered to be safer for canoeists and also reduces the amount of debris caught on the weir.
5. An open channel was considered to convey water from the weir to the headpond. This is cheaper to construct than a covered conduit. The covered conduit was adopted to avoid the open channel forming a barrier to animal movement, and resulting in animals possibly drowning in the channel. It also means interruption to drainage lines is minimised. Once the ground surface is rehabilitated the conduit will not be visible except for five or six personnel access points to inspection and maintenance.
6. A sedimentation basin is still being considered and may be adopted depending on the outcomes of sedimentation studies. This will be contained within the headpond.
7. A higher weir was considered, as it would allow greater regulation of the flow and decrease the depth required for the headrace canal, which would reduce construction costs. It would, however, increase the size of the pool behind the weir and increase the possibility of upstream impacts on farm land. The currently proposed weir crest level has been set to minimise the size of the weir pool and ensure there is no impact on upstream farms at all flow rates.

5.2.2 Technology alternatives

The principal technology choice is the type of turbine to be used for the facility. There are two major types of turbine – impulse and reaction – and the choice depends largely on the driving head and the available flow rate through the turbine, with efficiency and cost being additional factors influencing the decision.

An impulse turbine is usually used in high-head / low-flow applications, while this case, where the head is relatively low and the flow relatively high, requires the use of a reaction type.

The Francis turbine selected for this project is the most common turbine in use today. This type of turbine can be used for a wide range of heads, flow rates and generating capacities, and is of

robust design and construction that is relatively easy to maintain.

5.2.3 The operational aspects of the activity

The project has been designed to minimise operational activities that would result in disturbances to the wild and natural environment in which it will be situated. The location of the major project elements, the power house complex, is situated on the RVM land, and is as remote from the tourism centres in the AFNP as possible. Regular maintenance visits to the elements closest to the visitor centres – the weir and offtake structures - will be as infrequent and unobtrusive as possible.

5.3 The No-Go Alternative

The advantages and disadvantages of not implementing the project – the No-Go option – are discussed in section 7.1 of this report, for every aspect of the project.

6 KEY FINDINGS OF THE SPECIALIST STUDIES

6.1 Agriculture Report

A desktop agricultural potential assessment was conducted for the study area. The study utilised the Agricultural Geo-referenced Information System (AGIS) data provided online by the Institute of Soil, Climate and Water of the Agricultural Research Council. It was determined that the project would have a negligible impact on agriculture. Shallow soils and aridity constraints mean that the site is not currently used for agriculture, and is unlikely to be used for agriculture in the future. Most project infrastructure is planned upon land type Ag2. Soils across this land type are shallow, red, sandy soils on underlying rock and are classified as Hutton, Mispah and Glenrosa soil forms according to the South African soil classification system. Most of the site has a land capability classification, on the 8 category scale, of: Class 7 - non-arable, low potential grazing land. The rocky gorge areas are classified as Class 8 - non-utilisable wilderness. The shallow soils and the aridity constraints mean that agricultural land use (except along the connecting transmission lines) is restricted to low intensity grazing only. The natural grazing capacity is low. It varies with distance from the river from 18 to as low as 60 hectares per large stock unit.

The only agricultural impact of any significance is likely to arise due to the routing of the 132 kV overhead power line over irrigated agricultural land, but this can be reduced by consultation with the owners of land over which the line will pass, to agree on a suitable alignment and judicious selection of the locations of support structures.

6.2 Aquatic Ecology Report

Two field surveys were carried out at three representative sites in the general project area, the present Ecological Status and Ecological Importance and Sensitivity were assessed using standard South African methodologies, water quality parameters were measured in the field, and samples analysed in a laboratory. Since the environmental water requirements have already been specified at 30 cubic metres a second, one of the objectives of the study was to comment on its adequacy.

The river reach has suffered a change from its reference (pre-development) conditions in terms of biological integrity (fish, macro-invertebrates and riparian vegetation) as well as instream and riparian habitat, mostly as a result of transformed hydraulic conditions brought about by release management of upstream impoundments, and water quality impacts mostly from irrigated agriculture in the region. The resultant Ecological Category is an overall C class.

Even though there are transforming and degrading features present in the river reach the overall Ecological Importance and Sensitivity (EIS) remains High. Mitigation measures should be in place to ensure that these ecological categories are not degraded. This mitigation is regarded as viable since the Reserve will flow over the weir at all times, there is sufficient water in the river and the water used by the HPP will be returned to the river.

The surface water quality throughout the survey area is considered good, with the aquatic system supporting a diversity of sensitive aquatic macro-invertebrate taxa. It is therefore imperative that contamination of the surface waters through deleterious effluents and runoff water be avoided. Regular monitoring of water quality to enable early identification of contamination is recommended particularly during construction. The source of any contamination arising from project-related activities identified though the monitoring should be identified and managed according to the best practice guidelines set out in the EMPr.

The proposed development is to take place within close proximity to an existing natural migratory barrier within the system (Augrabies Falls) and therefore any impacts to migratory species arising from the construction of the weir is thought to be minimal. It does, however, fall within an area of the river considered to be relatively productive, which offers good habitat type. It is therefore recommended that a fishway be considered for this structure, if studies indicate that it is

necessary, or if it is required by the Department of Water and Sanitation.

The diversion of water from the main channel of the watercourse will adhere to a strict minimum flow policy, meaning that flow to the main channel (and therefore over the Augrabies Falls) will never fall below an agreed 30 m^3/s due to the operations of the hydro power scheme. This is considered sufficient to maintain the section of the river that will otherwise be deprived of a portion of the flow volume.

6.3 Vegetation and Botanical Report

The Riemvasmaak study area is not botanically sensitive in a broad sense and apart from Lower Gariep Alluvial Vegetation, the flora and vegetation are not threatened. However, the environment is well conserved and is distinctly "wilderness". The low sensitivity of the vegetation should therefore not be interpreted as providing a license to negatively impact the environment. The ecosystem is largely intact and undisturbed.

Three vegetation types are found, namely Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. Neither Lower Gariep Broken Veld nor Bushmanland arid Grassland are listed in the National List of Threatened Ecosystems (GN R.1002, December 2011) but Lower Gariep Alluvial Vegetation is listed as **Endangered A1.** The reason for the loss of Lower Gariep Alluvial Vegetation is the intense agriculture (mainly table grapes and citrus) on the alluvial soils in the Groblershoop area and mainly west of Upington as far as Augrabies, but also further west along the Orange River where it forms the boundary with Namibia. In the study area Lower Gariep Alluvial Vegetation was encountered at the proposed intake or abstraction point and lining the river banks along the upper reaches of the Orange River and its side-channels above the Augrabies Falls; and along the subsidiary river channels north of the falls.

Lower Gariep Broken Veld (Figure 14 - green) is found on the rugged ultrametamorphic koppies and inselbergs (the Hardeveld) interspersed with low plains, along the Orange (Gariep River). The vegetation is sparse, dominated by shrubs and dwarf shrubs with perennial grasses. Annual species are more prominent in spring. Tall *Aloe dichotoma* var. *dichotoma* is found as scattered isolated individuals or groups as well as the ubiquitous black-thorn (*Acacia mellifera* subsp. *detinens*).

Bushmanland Arid Grassland (Figure 14 - red) is much more widespread than either of the other vegetation types that occur in the study area. In the study area the Bushmanland Arid Grassland is dissected by sandy seasonal ‘washes’ or streams.

The vegetation at the abstraction site is in good condition, undisturbed apart from the changes brought about by variable water levels, and not invaded by exotic mesquite. Occasional breaks in the vegetation are found where animal paths (antelope such as gemsbok, kudu) penetrate the dense bush to access the river. Establishment of a weir and abstraction point at this site will require removal of a number of trees and other riparian vegetation, and will dramatically change the riparian zone in this area not only by higher water levels caused by the weir but also by changing the general hydrology of the site.

The water conveyance is aligned along a side channel of the Orange River, and would traverse mostly Bushmanland Arid Grassland that is not botanically sensitive except for the presence of *Acacia erioloba* (camel-thorn) trees in some places. If any of these nationally protected trees are on the proposed conduit route, application for permits would be required to remove them. The conduit would be aligned at right-angles to the alignment of many drainage lines and seasonal sandy washes that flow downslope from north-east to south-west towards the Orange River. The conduit will be buried to accommodate these seasonal downwash flows, and so the hydrology and consequently the vegetation are unlikely to be significantly changed.

The potential impact of construction of the power-house and associated head pond will take place in Lower Gariep Broken Veld, and impacts can be mitigated by concerted post-construction

rehabilitation to ensure re-vegetation of areas disturbed during construction.

The construction of the intake weir will impact Lower Gariep Alluvial Vegetation to a small localised extent, and will not make a significant contribution to the cumulative loss of this Endangered vegetation type.

6.4 Faunal Report

A single faunal survey was undertaken relatively late in the wet season (9-13 February 2015).

The known diversity of the terrestrial vertebrate fauna in the project area was determined by a literature review. Species known from the region, or from adjacent regions whose preferred habitat(s) were known to occur within the study area, were also included. Checklists for terrestrial vertebrate fauna at Augrabies Falls National Park (AFNP) were updated and adjusted where necessary.

Field methods for compiling the species lists for all vertebrate groups mainly involved visual encounter surveys at day and night, and were supplemented with observations on scats, tracks, regurgitated pellets, nests, feathers and bird calls along paths, at water points, and when walking through the site.

The Northern Cape Province has a relatively low faunal diversity, particularly for aquatic species and large mammal herbivores. However, many desert-adapted reptiles and birds are endemic or near-endemic to the region. Amphibians are the least specious group of terrestrial vertebrates in the project area. Reptile diversity in and around the study area is high, with over 50 species known or likely to occur. The Nama Karoo supports a particularly high diversity of bird species endemic to southern Africa, and characteristically comprises species of open habitats, particularly larks. Much of the historical large mammal fauna in the region has been greatly reduced or even completely killed off. Some have subsequently been re-introduced into AFNP.

Sensitive areas: Wetlands and Riverine habitats

Wetlands and riverine habitats constitute features of conservation concern as they are process areas. They are essential for ecosystem functioning and process and provide niche habitats for a variety of plants and animals. These areas have very high sensitivity. The internal AFNP Management Plan has prioritized protection of the Lower Gariep Alluvial Vegetation as a ‘Special conservation area’. It has become increasingly rare in the region due to habitat loss for agricultural use. In the project area it forms part of the riverine habitats along the Orange River in the vicinity of the proposed weir. It also forms part of the northern drainage line of Riemvasmaak, particularly where it connects to the Orange River, and therefore forms sensitive bird habitat essential to the functioning of the AFNP IBA.

Sensitive areas: Steep Slopes and Rocky Areas

Steep slopes and rocky areas in the AFNP Sensitivity Map are protected for their intrinsic visual beauty. However, these areas are also important features of conservation concern. They are difficult to rehabilitate and are easily affected by changes in land use, with erosion being an important impact factor. In addition these areas support unique assemblages of dwarf succulents and bulbs, and are important reptile habitats, especially for near-endemic rupicolous species (that live among rocks, such as Augrabies Flat Lizard and Augrabies Thick-toed Gecko). These areas exist throughout the project area, but are particularly significant in the ‘Canyon Zones’ and project actions in these areas should be minimized. This is particularly important during the construction phase, where the dangers of erosion and impaired visual impact may become significant after construction of all access roads, but particularly the tail race tunnel haul road, and in the selection of construction material, e.g. borrow pits.

Conclusions

The project area remains relatively natural due to its recent history of management by the AFNP. The riparian vegetation is also largely intact, unlike that in upstream regions where it has largely been replaced by irrigated cultivation.

The project area is one of the 122 Important Bird Areas in South Africa. It retains significant components of Nama Karoo biodiversity, and due to its proximity to the AFNP forms an important component of protection of this biome.

Few amphibians occur in the Lower Orange River area, with a maximum of 12 species likely to occur in the project area. No amphibians are endemic to the region and no amphibians of conservation concern occur. The most sensitive habitats for amphibians are perennial pools of water in the Orange River palaeochannels.

Reptile diversity in the region is much greater, with 57 species known in the region. Two lizards are Near Endemic to the region, but no reptiles of conservation concern are present. The most sensitive habitats for reptiles are expansive rocky areas, particularly in the 'Canyon Zone'.

Although 247 bird species have been recorded for AFNP, many of these are of seasonal, irregular or vagrant occurrence. Only 111 species were recorded during the brief survey. Fourteen (14) birds of conservation concern are recorded in the region, whilst 15 species are near endemic or are range or biome-restricted species. The most significant avian SCC recorded in the region are Kori Bustard (VU), Black Stork (NT), Openbill Stork (NT), Lanner Falcon (NT), Rosy-faced Lovebird (NE), Karoo Lark (NE), Karoo Long-billed lark (NE), Black-eared Sparrowlark (NE) and Namaqua Warbler (NE). The most sensitive habitat for birds is the riparian vegetation along the Orange River and its palaeochannels.

Large mammals are no longer a feature of Northern Cape landscapes, except in protected areas. In 2012 150 head of game (mainly Springbok, Gemsbok and Eland) occurred in the Riemvasmaak region. The majority of mammals present are small to medium-sized, and the micromammal component in the region is much greater than indicated on the AFNP mammal checklist. Mammals use all habitats in the region, and the rock fissures and cracks of the Canyon region form roosts for large numbers of bats, which play an important role in the control of insect pests over the irrigated agricultural lands, as well as controlling black fly pests that have a significant economic impact in the region.

There are few SSC for all faunal groups in the region, and most are well protected in the AFNP. The use of the Riemvasmaak as a Hook-lipped rhino refuge is no longer viable for security issues, but the area presents suitable habitat for this species.

Rocky outcrops and cliffs in the 'Canyon Zone' of the Riemvasmaak region should be avoided as these are visually sensitive and also form important habitat for rupicolous lizards, birds, and the Marbled Rubber Frog.

The Riverine habitats at the weir site, and in the palaeochannels of the Orange River, form sensitive wetland habitats, important habitats for amphibians and birds, and drinking points for large mammals.

The upper 'palaeochannel' forms a significant ecological corridor of high sensitivity. The route of the proposed water conduit runs in very close proximity to the right edge of this drainage line.

6.5 Seismic Study and Geotechnical Report

In January 2015 the Council for Geoscience undertook a desktop investigation to characterise the geological, geotechnical, seismic and topographical properties of the proposed project site.

The focus of the study was the main infrastructural elements of the project: the weir; twin-culvert headrace, headpond; underground power chamber and tunnelled tailrace. The power lines from the project to the national grid were considered only where they are to run underground, mainly along the route of the headrace. The routes and locations of these structures are shown in Figure 3.2 in Chapter 3.

6.5.1 Rock for construction material

Due to low chemical weathering rates in the area and the roughly granitic chemical composition of the bedrock on the site it can be assumed that a large percentage of bedrock will be unweathered or slightly weathered, and will have high strength and durability. The apparent massive fabric of the bedrock indicates that it will probably break to spherical or cubic clasts (that is, not into shards), and rock from excavations is expected to serve as an excellent source of coarse aggregate. This will particularly be the case in the tailrace area where excavation will be relatively deep and into unweathered rock. However, faults occurring in the headpond area may reduce the quality of aggregate from that area, because the rock may be in a more advanced state of weathering, and may therefore be softer and less durable, and likely to break into shards.

6.5.2 Hydrogeology

Studies during the last ten years or so have indicated that the regional groundwater level in the project area occurs at a depth of 30 to 60 metres below ground level, but that groundwater strikes can be expected in weathered rock within the first 20 metres below ground level, and groundwater may be encountered within 7 metres of ground level due to structural and metamorphic variance of bedrock.

It is unlikely that groundwater in bedrock will be encountered in excavations for the headrace, but subsurface drainage can be expected to occur from time to time within surficial soil cover. Because of the strong geological structure in the headpond area water strikes in areas of temporarily elevated water levels in bedrock could be expected in excavations at depths of as shallow as 7 metres. Groundwater may possibly effect the deep excavation for the power station cavern and the tailrace connecting it to the deeply eroded channel downstream.

6.5.3 Seismic hazard

Analysis of long-term seismic data by the Council for Geoscience data indicates that all areas in South African have Modified Mercalli Intensity scale hazard classifications of VIII or less (see Figure 6.1).

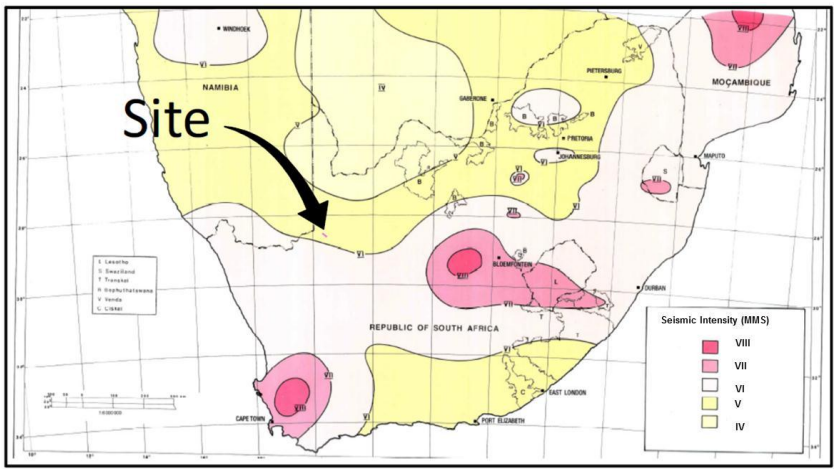


Figure 6.1: Seismic intensities in Southern Africa
Source: Council for Geoscience, 2015, Figure 6

The project area has a low seismic hazard, with a 10% probability of a peak horizontal acceleration of 50 cm/s^2, and events with Modified Mercalli scale V intensity being exceeded once every 50 years.

A comparison between the Modified Mercalli scale and the more familiar Richter scale[5] is shown in Table 6.1, from which it can be seen that scale V events are not considered sufficiently intense to cause damage to built structures, while scale VI events may cause damage to plasterwork, and scale VII events may cause slight to moderate damage in well-built ordinary structures.

Table 6.1: Comparison Modified Mercalli Intensity and Richter magnitude scales

Modified Mercalli Scale Intensity	Richter Scale Magnitude	Description of physical effects
I	1,0 - 3,0	Not felt.
II-III	3,0 - 3,9	Felt indoors on upper floors. Vibration like passing of a truck. Standing cars rock slightly.
IV-V	4,0 - 4,9	Felt outdoors. Hanging objects swing. Vibration like heavy truck striking building. Unstable objects overturned. Standing cars rock noticeably. Some windows broken.
VI-VII	5,0 - 5,9	Weak plaster and masonry cracked. Some chimneys broken. Slight to moderate damage in well-built ordinary structures; considerable damage in poorly built or badly designed structures.
VIII-IX	6,0 - 6,9	Damage slight to considerable in specially designed structures with partial collapse. Buildings shifted off foundations.
X and higher	7,0 and higher	Damage varies from "masonry and frame structures destroyed with foundations and rails bent" (X) to "total destruction" (XII).

Source: Council for Geoscience, 2015, Table 2

Work by the Council for Geoscience has identified and defined the occurrence of a recent earthquake swarm in the Augrabies area, which commenced in July 2010 and consisted of continual small seismic tremors. Up to the end of December 2014 the swarm has included 16 seismic events with magnitude of between 4.0 and 5.0 on the Richter scale. Figure 6.2 shows the area of occurrence of these larger tremors, the epicentres of which are shown as yellow dots on the figure, which is an elongated belt 55 km long and 17 km wide, starting from south of Kakamas and extending in a north-northwesterly direction continuing roughly parallel to the course of the Orange River and up to roughly 6 km north of the site of the proposed hydropower project. However, if all smaller tremors are included the area of occurrence is much larger, with a footprint approximately 290km long by 65 km wide, elongated in the same direction.

Figure 6.3 shows the timeframe over which tremors with a Richter magnitude exceeding 3.0 (approximately Modified Mercalli intensity scale II) have occurred since the start of the phenomenon. It can be seen that no events of magnitude equal to or greater than 3.0 have occurred since 2012, and not a single event exceeding a magnitude of 5.0 (approximately Modified Mercalli intensity scale VI) has occurred during the currency of the swarm. Nevertheless, all structures will have to be designed to resist tremors at least equal to the maximum magnitude recorded during the swarm this far.

[5] The Modified Mercalli scale measures the intensity of an earthquake in terms of its effects, while the Richter scale measures the magnitude in terms of the energy released.

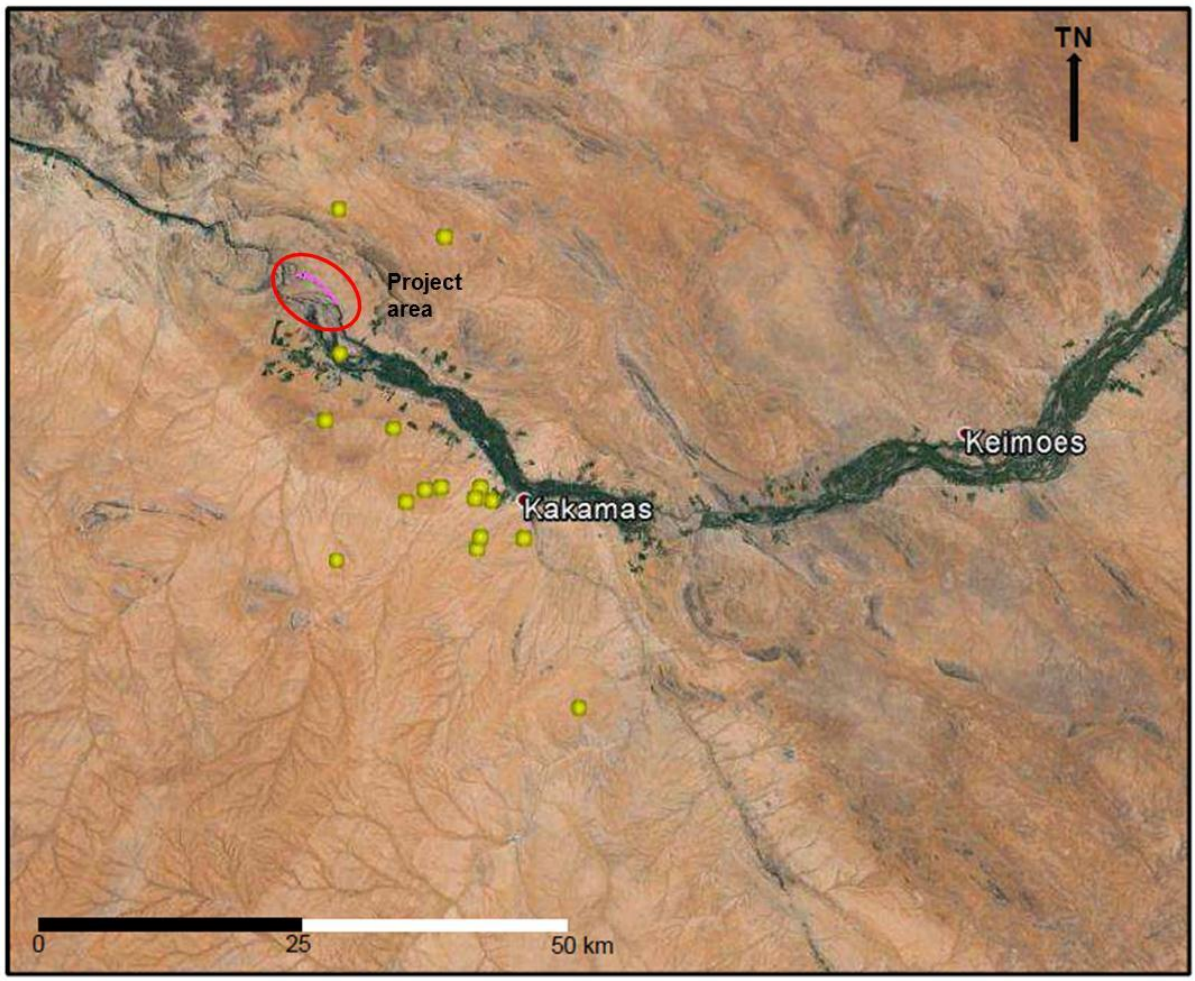


Figure 6.2: Locality of the recent earthquake swarm in the Kakamas area
Source: Council for Geoscience, 2015, Figure 7

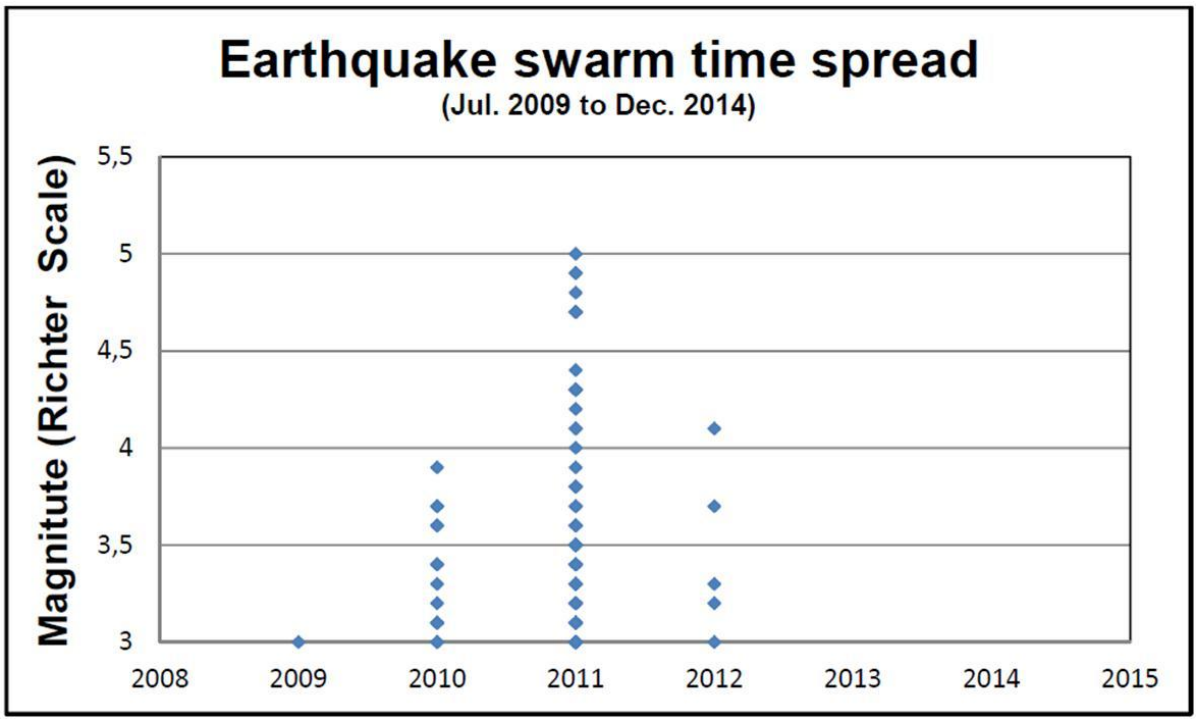


Figure 6.3: Timing of the earthquake swarm in the Kakamas area
Source: Council for Geoscience, 2015, Figure 8

6.5.4 Risk of cavity formation and possibility of slope failures

It is considered highly unlikely that cavities could form, as the local geology is not conducive to the formation of cavities or sinkholes (it is not dolomitic terrain).

Due to the very low surface slope over the first 3.5 kilometres of the headrace route, rock slope failures will not occur over that section. However, side slopes of the excavation for the headrace may be locally unstable during construction, particularly in areas where sand cover occurs on top of the bedrock. The excavation side slopes may have to be shored in those areas. Due to the steep slopes and geological jointing / faulting occurring over parts of the north-western section of the headrace route, small-scale rock slope failures of both the natural ground surface and excavation sides may readily occur. To ensure safety during construction, assessments need to be continually undertaken on site by a suitably qualified person.

6.5.5 Presence of buried structures

The site is remote, and the likelihood of buried structures being found along the routes and at the locations of the proposed structures is extremely small, particularly since bedrock generally occurs at relatively shallow depth.

6.5.6 Recommended further investigations

The study is based on previously documented information obtained from a number of sources. A detailed and accurate account of the site-specific geotechnical and geophysical conditions and possible constraints should be determined through additional site testing. Recommended studies include the following:

- Local geological surface mapping of the sites of project infrastructure in order to better establish site conditions and recommend test pit/drill spacing.
- Determination of the rock profile in the river in order to establish conditions for construction of the weir. Diving with a stave and camera should be considered.
- Test pit digging and rock core drilling and logging along the centreline of the headrace route, the site of the power chamber and the route of the tailrace prior to construction in order to establish thickness and properties of soil cover and rock mass properties, including degree of weathering, hardness, discontinuity properties and rock type variation. The digging / drilling needs to be as deep as final construction depth for the specific infrastructural element and needs to be spaced at short enough distances along the route to ensure a proper prediction of site conditions over the entire site. Closer spacing is expected to be necessary in the headpond-power chamber-tailrace area due to the expected poorer rock mass properties and location of more sensitive structures in this area. Pit / hole spacing could be increased, and numbers reduced, by undertaking a geophysical traverse (electrical resistivity, seismic) survey along the site route.
- Definition of site specific soil / rock conditions by means of on-site and laboratory testing to determine engineering characteristics of the materials. This can include soil grading and shear strength as well as compressive strength and durability of rock and deformability of the rock mass. These parameters can be of use for both establishing excavation properties of soil/rock mass and material properties for use in construction.
- In view of the recent earthquake swarm in the area, and also the location of the headpond, power chamber and tailrace on or in the immediate vicinity of a suspected geological fault zone, a site-specific seismic assessment should be undertaken of this part of the site.
- Determination (measurement) of water table depths as well as rock permeability in boreholes. This is particularly of relevance in the headpond, power chamber and tailrace area.
- Slope stability analysis of specific locations with steep topography and poor rock mass properties, where fixed structures (headrace, headpond and tailrace) or temporary construction infrastructure is planned. This is expected to be particularly relevant to the

northern parts of the site.

6.6 Heritage Impact Assessment

The site was visited on 27 and 28 November 2012 by ACO Associates, who wrote the Heritage Impact Assessment report. Specific heritage resources were identified, with GPS co-ordinates and photographs taken.

Palaeontology

Given the igneous rocks of which the landscape is comprised, palaeontological material would not occur in the area's hard geology. Almond and Pether (2008) note the Namaqua-Natal Metamorphic rocks to have no palaeontological significance, since no fossils have yet been recorded in them. However, it is possible that isolated fossils might be present trapped within the silt deposits on the Orange River floodplains. These would most likely comprise of tiny plant and animal remains.

Archaeology

A wide variety of heritage resources was recorded. These included scatters of Middle (MSA), and Later Stone Age (LSA) and historical artefacts, LSA occupation sites with deposits and historical occupation sites with ruined structures and artefacts of varying age. Significantly, a number of graves and many more stone features that may or may not be graves were located. A stone memorial was also found. All the historical features together comprise a relatively recent (20th century) cultural landscape but it should be noted that the community who created that landscape have given permission for the development to proceed. This serves to temper the significance of the cultural landscape and individual features of which it is comprised.

The following recommendations are made:

- The project should be allowed to proceed;
- All known graves should be avoided unless the community authorises exhumation and reburial;
- An attempt should be made before further planning progresses to identify any other graves known to the community and which are not clearly identifiable today (these would include all the stone mounds recorded during the present survey);
- A final walk-down survey should be undertaken once final (and accurate) alignments are available. The spatial extent of the impacts (disturbance corridor) will also need to be indicated prior to this survey. Note that it may not be necessary for all areas to be rechecked – this can be determined through comparison with the track of the present survey;
- Prior to commencement of any mitigation or construction, a plan needs to be in place that stipulates exactly how any disturbed human remains should be treated, whether these are found during mitigation or during construction (this is very important since it is considered highly likely that human remains will be disturbed, no matter what preventative measures are put in place prior to construction); and
- After the walk-down survey an accurate assessment of what archaeological mitigation will be required should take place. Mitigation will then need to be carried out under a permit issued to the responsible archaeologist by SAHRA.

6.7 Baseline Noise Assessment

Increased noise above ambient levels will be directly linked with the various activities associated with the construction, operational and decommissioning phase of the activity. The likely acoustic implications of the project, resulting from the specific activities relating to these phases of the facility, are considered at screening level; using the recommendations in SANS 10328:2008 - Methods for environmental noise impact assessments.

Daytime noise levels associated with construction activities are expected to be limited to an area within 500 metres from the activity. The nature of the noise is generally more impulsive and in a sensitive natural environment animals will try to relocate further from the noise source.

The information available is adequate to conclude that there will be a low potential for a noise impact during the construction phase due to the large distance between receptors and construction areas (project footprint and construction road traffic noise). There is a low potential of a noise impact during the construction of the over-head power lines, especially when this work takes place within 500 metres from potential noise-sensitive developments. It is the opinion of the author that the potential of a noise impact would be of a low significance. However, it is recommended that, should serious concerns about noise be raised by stakeholders during the public participation process, a Scoping-level Noise Assessment should be conducted.

It must be emphasised that the most significant phase relating to noise is the operational phase, and not the construction phase. This is because the duration of activities during the construction phase are generally short, while that of the operation phase is throughout the life of the operations. However, the potential for noise nuisance associated with the operational phase is considered to be very low. This is because the hydro-power generation equipment, which is to all intents and purposes a single point source noise contributor, is expected to be situated inside a building constructed from concrete/brick and mortar and buried 120 metres underground. These construction materials have a significant influence on the attenuation of noises from the equipment to the outside, with attenuation ranging between 20 and 30 dB resulting in a significant reduction in the noise levels and the extent of the potential noise impact. The nature of the noise is generally broadband, but if tones are present it may increase the risk of annoyance levels. Considering the worse-case scenario, due to the fact that the equipment will be situated inside a building the potential of a noise impact will be limited to the immediate surroundings. The criteria as set out in the SANS10328:2008 guidelines indicate a low potential for a noise impact during operations and that no further acoustical studies would be required.

Overall this assessment could not identify human receptors living within 2 000 metres from the proposed development (excluding the power line, where the impacts of noise are assessed as low). Because this is a baseline / screening assessment its scope is limited to potential impacts on human receptors, and no opinion is expressed on the potential risks and impacts of noise on non-human receptors in the natural environment.

6.8 Socio-economic and Tourism Assessment

6.8.1 Overview

In 2014, ACER was commissioned by the applicant to conduct a Socio-Economic Impact Assessment (SEIA) for the proposed hydropower station. The project is situated on the farm Riemvasmaak (Portion 1 of Farm No 498), as well as the remainder of Farm No 497 within the Augrabies Falls National Park (AFNP). There will be permanent land acquisition for the substation to be constructed on private land adjacent to the park.

The following section of the report provides a summary of the key findings of the SEIA. The section does not elaborate upon the impacts, which are discussed in Chapter 7.

6.8.2 Project Employment Opportunities

The project is anticipated to provide between 150 to 200 temporary opportunities during the construction phase, whilst between five and ten permanent opportunities will be created during the project's operational phase. Most of the opportunities will be afforded to the surrounding communities, which should increase the general wages of some households during the construction phase. This should impact positively on the local economy, as the disposable income will be increased. It should be noted, however, that such employment would only be temporary in nature (approximately three years), resulting in the fact that such workers might find themselves

unemployed after completion of their work. It is therefore noted that skills development could be a significant contribution of the project on the community members' ability to find alternative work in similar fields.

6.8.3 Key Findings

Project-Affected Communities (PACs)

The project is located around 32km north-west of the town of Kakamas, in the Kai !Garib Local Municipality (LM), in the ZF Mgcawu District Municipality (DM), in the Northern Cape Province of South Africa The Northern Cape is the largest province in South Africa, with population figures for the DM and LM respectively estimated by Statistics South Africa (StatsSA) at 236,783 and 65,869.

Although the site is culturally significant, no concerns have been raised regarding damage to existing graves, historical artefacts or other areas of cultural significance to the Riemvasmaak Community. Apart from this community trust land, which has a unique cultural heritage value in South Africa for being the first land restitution case settled after 1994, the Project-Affected Communities (PACs) and areas where the majority of the local labour will be sourced from include the town of Augrabies in the Northern Cape.

Education

Despite general improvements recorded in the educational status of the PAC residents, access to schools in the municipality area is below the provincial and district average. With a similar trend in tertiary education in the local municipal area, the findings point to a need for general improvements in educational facilities and access to such facilities. The nearest school facilities include three primary schools/crèches and five primary schools in the Augrabies and Riemvasmaak areas. There is no secondary school in Augrabies or Riemvasmaak.

Economic Sectors and Unemployment

According to the SEIA report, the agricultural sector remains the key economic driver of the district municipality. This sector contributes around 51.8% to the municipality's Gross Domestic Product (GDP), and accounts for 66.5% of all formal employment in the district. In particular, this industry is well-known for the cultivation of grapes and raisins for export purposes. A growth in the citrus production levels has also been recorded in recent years. Increasingly, more emerging farmers are becoming involved in small-stock farming, as well as in lucerne, cotton, corn and nut production.

Apart from agriculture, the area has also been identified by the Government as a suitable area for the generation of sustainable energy, particularly solar energy. Tourism, alternatively, is also one of the area's major economic development areas. In explanation, the DM has several tourist attractions, of which the Kgalagadi Transfrontier Park, the Spitskop Nature Reserve and the AFNP are some of the most well-known.

Considering unemployment levels, StatsSA reported in 2011 a general decline in unemployment levels for the LM; declining from 16.1% in 2001 to 10% in 2011. According to the SEIA, these figures are below the provincial and district unemployment average figures for 2011 (28.1% and 21% respectively).

A key finding from the SEIA is that members of the local communities, ward councillors and local government officials highlighted what they believe to be a concerning issue of unemployment and few employment opportunities in the region. These are seen as challenges faced by the area's communities which deserve attention.

Access to basic services

Access to piped water in the LM is reported to be worse than access to such water in the DM. What is highlighted as a concern in the SEIA is the fact that there seems to have been very little improvement in such access between 2001 and 2011. For example, according to StatsSA (2011), 7% of households in the LM reported not having access to piped water in 2011. Concerning sanitation, a similar situation has been recorded. Access to sanitation seems to be worse in the LM compared to the DM, as 12% of households in the LM reported not having access in 2011. These findings point to the fact that access to these services is generally lower in the LM as compared to the DM, which requires local-level intervention.

Access to electricity is better in the LM compared to the rest of the province, as 88.2% of households in the LM reported having access to electricity for lighting in 2011.

Healthcare

According to the SEIA, there is a satellite healthcare clinic in Augrabies and a permanent clinic in Riemvasmaak. However, access to healthcare remains dire in comparison to South Africa. The key healthcare challenges identified by the SEIA include HIV/Aids, high rates of teenage pregnancies and Tuberculosis (TB). In terms of medical facilities, challenges include a lack of sufficient and qualified healthcare practitioners, as well as a lack of health equipment and medication.

Population Influx

Most employment opportunities will be created during the project's construction phase. According to the client, the majority of the labour will be sourced from the surrounding communities as per the Independent Power Producers process. A significant population influx is therefore not anticipated due to the remote nature of the project. The SEIA does allude, however, to the fact that a general influx of job-seekers might be expected, as would be the case with any development. It has therefore been noted that some communities might experience some degree of possible in-migration, such as Kakamas, Augrabies and Marchand.

6.9 Visual Impact Assessment

Note: *This summary is adapted from the specialist report (MetroGIS February 2014 – see Specialist Report Volume), which was conducted for the original application for two 10MW projects, fed by a single headrace (see Figure 5.1). The text of the specialist report has not been altered, but references to any elements of infrastructure that are not included in this present 40MW project have been excised in this summary.*

The land on which the project is located is zoned, according to the internal Augrabies Falls National Park (AFNP) Management Plan (2013), as both "Primitive" and "Remote". The project infrastructure also falls within the priority natural areas buffer as well as the viewshed protection areas.

The purpose of the park zoning is, "*To establish a coherent spatial framework in and around a park to guide and co-ordinate conservation, tourism and visitor experience initiatives*" (AFNP, 2013). The zoning of AFNP was based on an analysis and mapping of the sensitivity and value of the park's biophysical, heritage and scenic resources; an assessment of the regional context; and an assessment of the park's current and planned infrastructure and tourist routes / products; all interpreted in the context of park objectives.

The power station and associated infrastructure, although located on Riemvasmaak land, is situated within the Remote zone while the water conveyance and electricity distribution infrastructure and access road span across the Primitive zone. The weir for water abstraction from the Orange River is also situated within this zone.

The Remote zone's characteristics are summarised in the AFNP Management Plan: "*Retains an intrinsically wild appearance and character, or capable of being restored to such*", where the

experience should be one of solitude and awe inspiring natural characteristics. The aesthetic and recreational conservation objective for this zone is: "*The area should be kept in a natural state, and activities which impact on the intrinsically wild appearance and character of the area, or which impact on the wilderness characteristics of the area (solitude, remoteness, wildness, serenity, peace etc.) should not be allowed*".

The Primitive zone should "*generally retain its wilderness qualities, but with basic self-catering facilities (concession facilities may be more sophisticated). Access is controlled. Provides access to the Remote Zone, and can serve as a buffer*". This zone is suitable for small, basic, self-catering; or limited concessions with limited numbers (concession facilities may be more sophisticated); 4x4 trails; hiking trails.

The power station and associated infrastructure are also located within the Visual Protection Special Management Area. This area is described as "*Areas where developments could impact on the aesthetic quality of a visitor's experience in a park. This zone is particularly concerned with visual impacts (both day and night), but could also include sound pollution*".

The affected environment from the Visual Impact Assessment's perspective is as follows: the towns of Augrabies (13.8 km from nearest edge of town to infrastructure located furthest away (tailrace and outfall); 3.8 km from nearest edge of town to infrastructure located closest (132 kV overhead line), Witklip, and Rooipad lie to the south of the AFNP and are the nearest urban areas to the project infrastructure. Settlements and homesteads are limited in number, and clustered along the secondary roads. The very limited large-scale electricity and industrial infrastructure within the region includes the Renosterkop Substation in the south east and the Blouputs to Renosterkop 132kV power line. The vegetation of the area is sparse, and therefore will not assist to block views of the project infrastructure.

The visual exposure and ultimately the visual impact of the headrace and power station is expected to be predominantly relevant for the construction phase (two to three years), since these elements of the project infrastructure will be for the entire operational phase of the project. Visual exposure is expected to be restricted to tracks and pipeline servitudes (features without any vertical dimensions) only. Vehicular movement and other human activity along the linear infrastructure and at the power station site should be very limited (that is, virtually negligible).

However, certain infrastructure components will be visible throughout the project's existence, namely: the weir and offtake structure, the power station headworks, the spoil heaps, the substation, and the 132 kV overhead powerline.

The following assessments are relevant for this project:

- The anticipated visual impact of construction is likely to be of **moderate** significance, both before and after mitigation.
- Potential visual impact on users of secondary and other roads in close proximity of the proposed power station (that is, where visible within a 1km of the proposed infrastructure) is expected to be of **moderate** significance, and may be mitigated to **low**.
- The potential visual impact on residents of built-up areas and towns within the region is expected to be of **low** significance, before and after mitigation.
- The visual impact on sensitive visual receptors (i.e. users of roads and residents of homesteads and settlements) within the region beyond the 1km offset is expected to be of **low** significance for all options, before and after mitigation.
- Potential visual impact on tourists and visitors to the Augrabies Falls (especially the AFNP Tourist Complex and local hikes and walks along the gorge) are expected to be of **moderate** significance and may be mitigated to **low**.
- The visual impact of the 132kV overhead power line expected to be of **moderate** significance. No mitigation is possible.
- The anticipated visual impact of the facility on the regional visual quality, and by implication on the sense of place of the region is expected to be of **moderate** significance during the

construction phase and **low** during the operational phase.
- Potential visual impact on tourism potential north of the Orange River is expected to be **low** as the project infrastructure will be placed below ground.

6.10 Economic Impact Assessment

6.10.1 Agriculture

Just over one-half of the Kai!Garib municipal GDP is accounted for by the agricultural sector, which is dominated by fruit, livestock and game farming. The main activity is the production of table grapes which are the first from the southern hemisphere to reach European markets, but there has been an increase in citrus growing, while lucerne, dates and nuts are also grown.

According to the Vin Pro Harvest Report (2012) the Northern Cape produces 49% of South Africa's table grapes, while the Orange River region contains 5% of the total area under wine grapes and 3.5% of the total number of vines in the country. The Orange River region produced 118 000 tons of grapes in 2012, down 8% on the 2011 figure, but the 2013 crop was expected to grow by 20%. Table grapes are exported, the United Kingdom and Europe remaining the major markets (79%) despite growth in the Far East. Wine grapes are sent to the Orange River Wine Cellars Cooperative Limited (ORWC) which is the second largest wine cooperative in the world and the largest in the southern hemisphere. It is headquartered in Upington but has a winery in Kakamas that is supplied by farmers in the area surrounding the RVM hydropower project.

The production of grapes has also led to the construction of packing stores and coolrooms on major farms as well as in Kakamas. The industry as a whole has transformed the economy of the area since the 1960s. Vine-fruit products (raisins and sultanas) are important in the Northern Cape. In the study area there is one raisin factory in Marchand and a depot in Kakamas of SAD Vine Fruit (Pty) Limited, the largest dried vine-fruit packaging and processing plant in South Africa with headquarters in Upington. In addition, there are two factories between Kakamas and Keimoes.

The Population Census of 2011 indicates that 23.5% of agricultural households in Kai!Garib are in receipt of incomes of between R4,801-307,200 per annum while 5.6% receive over R307,000 per annum, these latter being the large-scale commercial farmers in grapes and citrus in the study area.

6.10.2 Manufacturing

According to the Siyanda IDP (p.21), manufacturing is in decline in the district "across the board", but its importance in the local economy might be understated, as agro-industry appears to be included under the agricultural sector in the Census figures, rather than under manufacturing.

Apart from agro-industry such as wineries and an abattoir in Kakamas, there is a brick factory on the road near Marchand and the usual array of small manufacturing workshops that characterise a town serving an agricultural community. The growth of such enterprises is tied up with the economic circumstances of the agricultural sector.

6.10.3 Tourism

Although new investment continues to be attracted to this sector, the Siyanda IDP pointed out that the volume of tourists was insufficient to act as a driver of the economy (p.21). Nonetheless, it was the fastest-growing component of the economy between 2007 and 2011 (p.31). The Kai!Garib IDP states that there is substantial growth potential in the sector (p.18).

The vivid contrast between the green spine of the Orange River valley and the desert-type landscape to the north is remarkable and is unique in South Africa. The study area includes the major tourist attraction in the LM, namely, the Augrabies Falls which is situated in the Augrabies Falls National Park. It is the world's sixth largest waterfall and is located at the head of a deep,

18km-long gorge. The Park offers accommodation in the form of chalets, cottages, and camping and caravan sites. Day and night drives and nature trails are available to tourists, but the part of the Park adjacent to the RVM hydropower site is not open to visitors.

There is an unfortunate data gap regarding statistics in the LM and study area. There are three main lodges near the AFNP, the AFNP accommodation, a number of upmarket guest houses and a hotel and conference centre in Kakamas, and a number of guest farms and lodges (one with a ski school) between Kakamas and Augrabies. However, the data gap arises from the fact that accommodation establishments are not required to submit statistical returns to any official industry body. The experience of tourism consultants is that bed occupancy rates are invariably overstated, and that an annual average figure of 50-60% is the norm in South Africa. There are no data as to the total number of beds in the area, but there is no reason to expect that the bed-occupancy rate should deviate significantly from the national norm.

6.10.4 Retail, Wholesale and Other Sectors

Kakamas contains branches of KaapAgri, OK, Saverite and Pep Stores while a branch of Spar is under construction. A Chinese-owned supermarket opened in 2014. The sector is estimated by one operator as having grown at a rate of about 20% per annum, but growth is related to the price of grapes and is expected to be slower in 2014/15 because the price has fallen although this might be partly offset by the increased harvest size. The number of consumers swells significantly during the grape-picking season (September/October to February/March) when there is an influx of seasonal workers to the farms. The citrus season in the winter months does not attract as many seasonal workers as the vineyards. The size of the Kakamas retail and wholesale sector in terms of annual turnover was estimated by a leading enterprise at about R750 million.

This sector also contains small traders, both formal and informal which, it is reported, have been infiltrated in recent years by Asian traders, in keeping with the trend in the rest of the country

6.10.5 Transport and Communications

The growth of irrigated agriculture in the LM has led to the establishment of a substantial local trucking and logistics sector. The Wine Cellars, pack houses and coolrooms are served by fleets of trucks and trailers moving produce from the farms, one consequence being that traffic on the roads is often slow during the harvesting season.

6.10.6 Summary

The economy of the Kai!Garib LM is small in size and is dominated by agriculture and agro-industry which have substantial linkages with other sectors such as trade, transport, logistics, construction, utilities and financial services. The agricultural sector is highly dependent on the availability of water from the Orange River, and the management of that water is therefore an important factor in future economic growth. The general view encountered in interviews was that the scope for the expansion of irrigated agriculture was limited because of water availability. Economic diversification is therefore required, and a promising opportunity for this lies in the field of power generation using the area's endowment of renewable energy sources such as sun, wind and water. The Kai!Garib LM IDP (p.25) states that the generation of sustainable energy, particularly from solar power, has attracted interest from investors.

7 IMPACT ASSESSMENT

7.1 Existing Land-use / No-Go Impacts

7.1.1 Agriculture

Agricultural activities in the study area are minimal, since no agriculture takes place here. If the project does not proceed, there will not be any positive or negative impacts associated with agriculture.

7.1.2 Aquatic Ecology

Approach to assessing impacts

The approach to assessing the significance of impacts on the aquatic environment is slightly different to that adopted for the other studies, inasmuch as more parameters are considered in the assessment. The factors considered are: spatial extent (S); duration (D); intensity (I); effects on important ecosystems (E); the overall reversibility of the impact (R); and the probability of likelihood of the impact (P). Rather than attempt to combine these factors into the CES system, which has fewer parameters, the impact assessment tables have been included as they appear in the specialist report. In this system:

Conf = Degree of confidence in the validity of the assessment
SR = Significance Rating, for which the scale is:
0 – 33 = Low
34 – 74 = Medium (rendered here as Moderate for consistency with the CES terminology)
75 – 100 = High

The scoring system for each factor is tabulated below.

Spatial		Duration		Intensity		Ecosystems		Reversibility		Probability	
Rating	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**
Site specific	1	Short (0-15yrs)	1	Low	1	None	1	Irreversible	0	Improbable	1
Local	2	Medium (2-15yrs)	2	Medium	3	Negligible	2	Largely irreversible	1	Possible	2
Regional	3	Long (16-30yrs)	3	High	5	Insignificant	3	Somewhat reversible	2	More than likely	3
National	4	Discontinuous	4			Significant	4	Largely reversible	3	Highly probable	4
International	5	Permanent	5			Vast	5	Totally reversible	4	Definite	5

Existing Impacts / No-Go Impacts

Cause and Comment

The Orange River is a highly altered system. The construction of two very large dams, Gariep and Vanderkloof, respectively about 690km and 590km upstream of Augrabies Falls, have resulted in the establishment of large areas of irrigated agriculture along the river. These developments, together with transfers of water from the Senqu River in Lesotho via the Lesotho Highlands Water Project into Gauteng Province in South Africa, have resulted in a progressive reduction of runoff reaching the Atlantic Ocean at Alexander Bay of about 50%, from the estimated 11 000 million m^3/annum before any development took place to around 5 500 million m^3/annum at 2005 development levels. (ORASECOM 2007). Generation of electricity at Gariep and Vanderkloof dams, together with the need to supply water to the irrigated areas and mining operations along the river, has also altered the natural seasonal variations in flow in the river. Smaller floods have essentially been excised from the river's flow regime via attenuation through the impoundments, and only the larger floods pass through the dams relatively unaltered. The water quality regime of the river has been impacted by return flows from irrigated areas, and also by chemical pollution

from mining operations. Sediment loads in the river have been affected by sediment deposition in the various impoundments along the river, some of the smaller ones being almost completely silted up.

Mitigation Measures

There are no practical mitigation measures to reverse the effects of the progressive development of the river and its contributing catchments, and these impacts will continue to apply to the river in the vicinity of the project. It is possible that optimisation of water use in the Orange River basin, by effective programmes of water conservation and water demand management, for instance, together with implementation of measures to implement the environmental water requirements of the river, may serve to stabilise the current trajectory of degradation in the project area, as demands for water from the river increase in the future.

Significance Statement

Environmental impact	Activity / Issue	Environmental significance							
		S	D	I	E	R	P	Conf*	SR
EXISTING / NO-GO IMPACTS									
Degradation of ecological condition of river	• Abstraction and diversion of water • Pollution of water resources • Alteration of flow regime	5	5	5	4	3	5	High	**80 High**

7.1.3 Vegetation

From a botanical perspective the 'No Go' scenario would be the ideal since there would be no disturbance of a presently largely undisturbed ecosystem. There would be no necessity for removal of any vegetation, particularly trees, and there would be no disturbance of the soil. Management of the study area is currently under the control of SANParks with the objective being conservation of the ecosystem and its biodiversity. This is a highly desirable situation from an environmental perspective since the area is stocked with wild ungulates and is not grazed by domestic livestock. It is actively managed for optimal carrying capacity and is therefore not over-utilized. Access to the area is also restricted, resulting in a distinct sense of wilderness and aesthetic appeal that would have long-term benefits if the area was to once again be opened to limited 'wilderness experience' tourism. The *status quo* would therefore remain for the foreseeable future given the 'No Go' scenario but there could be changes e.g. 'wilderness tourism' that could be instituted in the future. This needs to be compared with the development of an industrial-scale facility that would impact a largely undisturbed natural environment.

7.1.4 Fauna

The Riemvasmaak land is currently managed as a part of the AFNP (it is referred to in the AFNP Management Plan as the Melkbosrant area). The area has been categorised in the internal Management Plan as Primitive and Remote Use zones. These are the highest protected areas, where human access (and associated impacts) is either fully curtailed or rigorously controlled.

Should the *Melkbosrandsamewerkingskomitee* agree to maintain existing management, as outlined in the internal AFNP Management Plan (2013-2023), this could be considered to be positive for faunal conservation in the region.

7.1.5 Heritage

The area contains scattered Middle Stone Age (MSA) and Later Stone Age (LSA) historical artefacts. A number of graves were found in the study area. These are not currently afforded any protection, except for their protection within the borders of the AFNP. They are likely to continue undisturbed if left in their present location and condition.

7.1.6 Noise

Increased noise levels are directly linked with the various project activities and are associated with the construction, operational and decommissioning phase of the activity. The existing land use has no noise related impact and is not discussed further.

7.1.7 Socio-economic and Tourism

There are no significant impacts associated with the no-go option, because the current socio-economic status quo should remain unchanged.

7.1.8 Visual

Although the Augrabies Falls National Park is situated in an area of rugged natural beauty the areas surrounding the park have been significantly impacted by human activity. Most of these developments, such as roads, residences, irrigated agriculture and overhead power lines are not regarded as being particularly discordant, since they have become a familiar part of the area. In recent years, however, there has been an increase in the area of vines covered by shade cloth, either light blue or, more commonly, white in colour. Some of these covered areas are quite large, up to 45ha in extent, and they are visible for considerable distances from the higher lying ground in the river valley. Areas of shade cloth in the vicinity of the project site are shown on Figure 7.1 and illustrated in Plate 7.1

Figure 7.1: Areas of shade cloth (white polygons) in the project area

	
45ha shade cloth area south of the river looking north	**6ha shade cloth area south of the river looking south**

Plate 7.1: Typical areas of vines under shade cloth ion the project area
Source: Google Earth TM Street View

Impact: The positive visual impact of retaining the area within the AFNP and surrounds undeveloped, in a natural state and with no visual intrusions.

Important Note: This assessment is exactly as presented by the specialist in Table 7 of his report (Table MetroGIS, February 12014 – see Specialist Report Volume). However, to describe an impact as positive explicitly implies that the present situation will be improved by not constructing and operating the project. The reality is that nothing will change, because there will be no project-related impacts - the No-Go situation is to maintain the status quo.

Cause and comment

The proposed infrastructure is located within a natural area of particular and unique rugged beauty. The natural environment is not only of a high quality, but is also unique. The presence of the Augrabies Falls within this setting contributes to this uniqueness, and is in itself a feature of national significance and of irreplaceable value.

Mitigation and management

Not applicable.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Regional	Beneficial	Definite	**HIGH+**
With Mitigation	NA	NA	NA	NA	NA

7.1.9 Seismicity

There will be no project-related infrastructure in the area, and seismic events will therefore have no effect. The No-Go situation is the current status quo.

7.1.10 Economic

Should the project not be authorised, constructed and operated the positive impacts relating to increased occupancy of hotels, lodges and B&Bs, increased retail turnover, increased employment financial benefits to community trusts, and community development programmes will not eventuate.

7.2 Design Phase Impacts

7.2.1 Agriculture

Activities associated with the design and pre-construction phase pertain mostly to background studies, surveys and data collection. The impact on agriculture in this phase is insignificant.

7.2.2 Aquatic Ecology

Design activities related to the aquatic environment involved selective sampling of aquatic organisms to determine the biological condition of the river, and taking and analysing samples to determine the chemical condition. The impacts of these activities are negligible.

7.2.3 Vegetation

Design phase impacts on the botanical environment are negligible. Specialists accessing the area are restricted to the roads, and when they need to enter the veld, do so on foot.

7.2.4 Fauna

Activities associated with the design and pre-construction phase will not have significant impacts on the biophysical, social or economic environment. The phase consists of planning and design around the proposed development, and is done mainly at desktop level. Field studies need to take place but the faunal impact of these visits is negligible.

7.2.5 Heritage

Activities associated with the design and pre-construction phase pertain mostly to background studies, surveys and data collection. The impact on heritage resources in this phase is insignificant.

7.2.6 Noise

Increased noise levels are directly linked with the various project activities and are associated with the construction, operational and decommissioning phase of the activity. Except where it relates to geotechnical investigations (see section 7.10 following), the design phase has no project related impact and is not discussed further.

7.2.7 Socio-economic and Tourism

Activities associated with the design and pre-construction phase will not have significant impacts on the biophysical, social or economic environment. The phase consists of planning and design around the proposed development, and is done mainly at a desktop level. Field studies need to take place but the impact of these visits is negligible.

7.2.8 Visual

Activities associated with the design and pre-construction phase pertain mostly to background studies, surveys and data collection. Visual impacts in this phase are insignificant.

7.2.9 Seismicity

Activities associated with the design and pre-construction phase will relate mostly to background studies, surveys and data collection. Seismic activity will not result in any impacts during this phase.

The design of the project infrastructure will, however, have to take account of the potential impacts of seismic activity on the various structures. With regard to reinforced concrete structures the design must follow good practice for earthquake resistance as set out in SANS 10160-4:2011 (Basis of Structural Design and Actions for Buildings and Industrial Structures — Part 4: Seismic Actions and General Requirements for Building). The design of the tailrace culverts should specify earthquake resistant measures such as flexible joints between sections of culverts, and granular material for bedding and backfill.

7.2.10 Geotechnical investigations

The requirements of the Draft Environmental Management Programme, as amended by the contractor, applicant and agreed by the Department of Environmental Affairs, for investigative work requiring machinery, equipment and, especially, blasting, must be strictly adhered to avoid negative impacts.

7.3 Construction Phase Impacts

7.3.1 Agriculture

Impact: Reduction of agricultural potential

Cause and comment

The loss of agricultural potential could be influenced by three project activities:

1. The sterilisation of agricultural potential by the project footprint
2. Disruption of the soil profile and vegetation;
3. Changes in the river level and flow due to weir construction and water abstraction

Since the agricultural potential of the site is considered to be minimal, loss caused by the project footprint is insignificant.

However the route alignment of the 132 kV overhead power line could cause the loss of agricultural production if it crosses irrigated land. Consultation with affected land owners will be required to minimise impacts in this regard, by seeking agreement on the proposed alignment.

Mitigation and management

Landowners should be consulted for their input into the best placement of pylons. Place all pylons off irrigated land, or if not possible, place between or at the edges of existing land units so as to have minimal disturbance of irrigated land.

Store topsoil separately for re-use later during site rehabilitation.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Slight	Probable	**LOW**
With Mitigation	Long term	Localised	Slight	Probable	**LOW**

7.3.2 Aquatic Ecology

Impact 1: Destruction of aquatic habitat to accommodate weir construction

Cause and comment

The construction of infrastructure will induce significant disturbance, but, upon completion the overall significance of this impact is considered to be localized and temporary. With proper site reinstatement the significance of the impacts will not carry over into the operations phase (see operations phase analysis for further details pertaining to this infrastructure development).

Mitigation and management

- The construction within an ecologically sensitive habitat feature needs to be considered and so the construction impacting footprint needs to remain as small as possible.
- Indiscriminate habitat destruction must be avoided.
- Consideration should be given to including a fish migratory bypass (fishway) into the weir design.
- Proper site and habitat reinstatement must be implemented during site rehabilitation following the completion of the construction phase. Any loose rocks or cobbles that are to be removed to accommodate the infrastructure should be stored in order to make use of the same substrates during reinstatement of the habitats that have been disturbed.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Duration, Intensity, Ecosystem impacts and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Destruction of aquatic habitat to accommodate weir construction	1	4	3	4	1	3	High	**33 Low**	1	1	1	2	2	2	High	**6 Low**

Impact 2: Destruction of local watercourses and side tributaries to accommodate the construction of the headrace

Cause and comment

The region is considered arid and the Orange River represents one of the very few perennial watercourses. Steep and undulating topography means that there are many surface water drainage lines that convey water during rainfall events. The degree of establishment of habitat is a function of the size of the local catchment area of the watercourse. This means that the watercourses are subject to greater or lesser volumes of surface water drainage and therefore are subject to greater or lesser potential for erosion to take place. Loose and unstructured soils are common, being either aeolian or alluvial in origin, and therefore are vulnerable to the effects of erosion. Further disturbances will merely aggravate the effects of erosion.

Mitigation and management

The proposed headrace conduit is an excavated closed box culvert that inevitably has to cross through numerous watercourses of varying scales (no watercourses represent aquatic habitat as no surface water is retained for any significant period). Therefore mitigation is limited to erosion control and allowing the free-flow and natural course of the surface water drainage. Indiscriminate

habitat destruction must be avoided and vegetation disturbance minimized.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Duration, Intensity and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Destruction of local watercourses and side tributaries to accommodate the construction of the headrace.	1	4	3	2	1	3	High	**27 Low**	1	1	1	2	2	2	High	**6 Low**

Impact 3: Reduction of water volume flowing over the Augrabies Falls to accommodate the hydropower scheme.

Cause and comment

In order for the hydropower scheme to function a portion of the water will be diverted from the main channel (that flows over the falls) through the canal to the turbines. This will deprive the aquatic habitat of that portion of water diverted to the power station for approximately 10 km. It is noted that at river flow rates below 30 m^3/s there will be no diversion of water through the scheme, which ensures that the river flow never falls below this flow rate as a result of project-related diversions during low flow periods. This is sufficient to ensure ecological functionality of the watercourse. Downstream of the falls the watercourse is constricted in a narrow gorge, which requires relatively less water volume for maintenance compared to the wide braided channel above the falls. Therefore this impact, from an ecological perspective, is not thought to be of major significance. The diverted water is returned to the main channel downstream and therefore the impact of the diversion is thought to be negligible to downstream users of the system. It is noted that a hydropower scheme is a non-consumptive use of the water resource.

Mitigation and management

Active management of the scheme is required to ensure that flow volume to the main channel is never reduced below 30 m^3/s as a consequence of the scheme. It is acknowledged that flow rates lower than this could occur due to management of upstream impoundments, upstream abstraction, or natural low season flows.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Duration and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Reduction of water volume flowing over the Augrabies Falls to accommodate the hydropower scheme.	2	4	1	1	1	4	High	**28 Low**	2	1	1	1	4	1	High	**4 Low**

Impact 4: Contamination of surface water features leading to loss of sensitive biota.

Cause and comment

Contamination could occur from leakage of fuel and other hydrocarbons from fuel storage tanks, vehicle and plant refuelling, servicing and washing. Poorly managed sewage and lack of proper ablution and toilet facilities can result in human waste polluting surface and groundwater sources.

Mitigation and management

Fuel and other hydrocarbons should be stored only in designated areas, which are properly bunded to contain any potential leaks. Construction vehicles should be properly serviced in order to avoid fluid leaks. Proper sewerage management should be implemented in order to avoid contamination of the surface waters through untreated sewerage (taking note that a contained package plant is proposed).

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability, and increasing Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Contamination of surface water features leading to loss of sensitive biota.	3	4	3	4	1	3	High	**39 Mod**	2	1	1	2	2	2	High	**8 Low**

Impact 5: Impacts on riparian vegetation leading to decrease in filtration of runoff

Cause and comment

This is not likely to be a significant impact as the development activities will only include a small area of riparian vegetation.

Mitigation and management

Indiscriminate destruction of riparian habitat should be avoided.

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability, and increasing Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Riparian Vegetation Impacts	Impacts on riparian vegetation leading to decrease in filtration of runoff.	2	4	3	3	2	4	High	**40 Mod**	1	1	1	2	2	3	High	**9 Low**

Impact 6: Biodiversity impacts due to riparian vegetation loss.

Cause and comment

This is not likely to be a significant impact as the development activities will only include a small area of riparian vegetation.

Mitigation and management

Indiscriminate destruction of riparian habitat should be avoided.

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability.

Potential environ impact	Project activity or issue	Environmental significance *before* mitigation**								Environmental significance *after* mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Riparian Vegetation Impacts	Biodiversity impacts due to riparian vegetation loss.	2	4	3	3	2	4	High	40 Mod	1	1	1	2	2	2	High	6 Low

Impact 7: Decreased flood attenuation capacity from removal of riparian vegetation.

Cause and comment

This is not likely to be a significant impact as the development activities will only include a small area of riparian vegetation.

Mitigation and management

Indiscriminate destruction of riparian habitat should be avoided.

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability.

Potential environ impact	Project activity or issue	Environmental significance *before* mitigation**								Environmental significance *after* mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Riparian Vegetation Impacts	Decreased flood attenuation capacity from removal of riparian vegetation.	2	4	3	3	2	4	High	40 Mod	1	1	1	2	2	2	High	6 Low

Impact 8: Increased rate of erosion from soil stripping, soil compaction and vegetation removal

Cause and comment

Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of

sediment into the general aquatic ecosystem. Erosion and transport of sediment into water courses can result in smothering of rock and cobble substrates, with consequent displacement or mortality of aquatic species.

Mitigation and management

Erosion must be strictly controlled through the utilization of silt traps, silt fencing, Gabions, etc. This is especially pertinent within areas of steeper gradients.

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability, and increase in Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Soils	Soil stripping, soil compaction and vegetation removal will increase rates of erosion and entry of sediment into the general aquatic ecosystem	2	4	3	4	1	4	High	**48 Mod**	1	1	1	2	2	2	High	**6 Low**

Impact 9: Erosion and habitat destruction from stockpiled topsoil and disturbance of soils

Cause and comment

Erosion and transport of sediment into water courses can result in smothering of rock and cobble substrates, with consequent displacement or mortality of aquatic species.

Mitigation and management

Erosion must be strictly controlled through the utilization of silt traps, silt fencing, Gabions, etc. This is especially pertinent within areas of steeper gradients.

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability, and increase in Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Soils	Erosion of stockpiled topsoil and disturbance of soils due to vegetation stripping leading to erosion and habitat inundation	2	4	3	4	1	4	High	**48 Mod**	1	1	1	2	2	2	High	**6 Low**

7.3.3 Vegetation

Impact: Loss of vegetation from constructing the intake structure

Cause and comment

The intake structure would require construction of a weir that would strongly negatively influence the vegetation of the riparian zone (Lower Gariep Alluvial Vegetation) but within a localized area. The impact would be that of the construction and operation of the intake facility on Lower Gariep Alluvial Vegetation.

Euclea pseudebenus is a protected tree species in terms of the National Forests Act 1998 (Act No. 84 of 1998). There is no doubt that this species would be negatively impacted by the construction of the intake facility, with the need to remove some trees for a distance of about 60m along the river bank. For this purpose a permit would be required.

Mitigation measures

Mitigation should involve shaping the river banks around the weir and abstraction point and re-establishing the riparian vegetation. Young trees of species such as *Acacia karoo*, *Searsia pendulina* and *Euclea pseudebenus* should be cultivated in a nursery and re-introduced to disturbed areas at the site after construction, under the guidance of a restoration ecologist. Mitigation measures such as these would lower the significance of the impact that without mitigation would be **High negative** but reduced to **Moderate negative** with mitigation.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Severe	Definite	**HIGH**
With Mitigation	Long term	Localised	Moderate	Definite	**MOD**

Impact: Loss of vegetation from constructing the headrace

Cause and comment

The proposal is to align the conduit (headrace) along a side channel of the Orange River. . The conduit would traverse mostly Bushmanland Arid Grassland that is not botanically sensitive except for the presence of *Acacia erioloba* (Camel-thorn) trees in some places. If any of these nationally protected trees are on the proposed conduit route, application for permits would be required to remove them.

A second important consideration in the zone of Bushmanland Arid Grassland is that the conduit would be aligned at right-angles to the alignment of many drainage lines and seasonal sandy washes that flow downslope from north-east to south-west towards the Orange River. The headrace would be buried to accommodate these seasonal downwash flows and so the hydrology and consequently the vegetation are unlikely to be significantly changed. If the conduit were to be above ground the result would be a High negative impact. Mitigation is therefore to bury the conduit. This design would have a considerable impact during construction since it would involve excavating a trench for the headrace. However, if post-construction mitigation is adequately applied, the impact could be reduced from High negative to Moderate negative.

Mitigation measures

Regardless of the construction option and methods adopted there would be major disturbance of the landscape (loss of Bushmanland Arid Grassland) but within a restricted zone. It would be imperative to have restricted construction zones; no access beyond these zones should be permitted. Vital mitigation would be to implement post-construction rehabilitation of vegetation in disturbed areas. In the arid environment that would be impacted, rehabilitation would take a long time. However, no foreign plant species e.g. foreign grass species should be brought into this environment. No hydro-seeding with grass-seed mixes of plant species not found locally should be permitted. In addition, measures should be taken to ensure that invasive alien shrubs, particularly mesquite (*Prosopis glandulosa* var. *glandulosa*) are not introduced into or allowed to colonise disturbed sites. The area must be monitored for at least four years after construction to assess the rehabilitation success or otherwise and to ensure that any invasive shrubs are eradicated.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Severe	Definite	**HIGH**
With Mitigation	Long term	Localised	Moderate	Definite	**MOD**

Impact: Loss of vegetation from constructing the powerhouse, headpond and tailrace

Cause and comment

Three possible sites were originally proposed for the Option 2 power-house (see Figure 5.1). They are Option 2A, Option 2B and Option 2C. Option 2C was recommended after the botanical field investigations carried out by the author, but was ‘screened out’ due to engineering constraints. It was therefore not considered any further in the assessment.

Both Option 2A and Option 2B are in similar terrain with similar vegetation (Lower Gariep Broken Veld). There is no strong botanical benefit in choosing the Option 2A site above the Option 2B site or vice versa. The potential impact of construction of the power-house and associated head pond, including the haulage routes into the palaeo channel, can therefore be taken to be equivalent from a botanical perspective at either of these sites and would be High negative at both. This could be mitigated by concerted post-construction rehabilitation to ensure re-vegetation of areas disturbed during construction. Such mitigation would lower the impact to Moderate negative.

Mitigation measures

Post-construction rehabilitation of the construction site is recommended.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Severe	Definite	**HIGH**
With Mitigation	Long term	Localised	Moderate	Definite	**MOD**

Impact: Effects of the transmission line and sub-station on vegetation

Cause and comment

It is proposed that power will be evacuated from the power house via an underground cable that will be laid in the same excavated channel as the headrace to the intake weir location. This would mean that there would be no additional construction apart from that required for the headrace over this section of the cable route. From a location near the intake weir (at approximately S 28° 35' 18.79" E 20° 21' 23.40") the cable would be buried alongside the site access road up to the proposed sub-station (S 28° 36' 40.04" E 20° 22' 30.59). From the sub-station the power would be evacuated via a 132kV overhead power-line. The route of the overhead line and the locations of the support structures have been determined in consultation with the landowners to minimise the impact on natural vegetation and cultivated lands. The impacts are considered to be negligible.

The impact of the underground cable on vegetation along the section from the power house to the road junction with the conduit route would be non-existent since it would be contained within the headrace channel. The impact would this be Low negative.

In the section where the underground cable would be buried alongside the access road the impact would be Moderate negative without mitigation on Bushmanland Arid Grassland. With mitigation that should be active re-vegetation of the disturbance from construction, the impact would be reduced to Low negative.

Mitigation measures

Post-construction rehabilitation of the construction site is recommended.

Significance statement
Impact of construction and operation of the underground power evacuation cable on Bushmanland Arid Grassland and Lower Gariep Broken Veld where the power cable would be in the same channel as the headrace.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Low	Definite	**LOW**
With Mitigation	Long term	Localised	Low	Definite	**LOW**

Impact of construction and operation of the underground power evacuation cable on Bushmanland Arid Grassland where the power cable would be buried alongside the site access road.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Moderate	Definite	**MOD**
With Mitigation	Long term	Localised	Low	Definite	**LOW**

7.3.4 Fauna

This section presents the issues that may impact terrestrial faunal systems arising from the construction of the hydropower project, including its associated infrastructure such as the access roads, particularly those associated with construction of the outflow tunnel within the lower

'palaeochannel', the excavation of the headrace route, the construction of the weir, head pond and power house, and the development of transmission line connections to the existing Eskom network near Augrabies.

Issue 1: Loss of Biodiversity

All faunal groups will suffer a general loss of biodiversity due to varied impacts, particularly increased mortality and migration away from the project area. This will result from various project actions, including collision with vehicles, loss and fragmentation of suitable habitat due to the footprint of project structures, and various forms of pollution associated with traffic and development. This will be greatest for small, slow-moving species, e.g. amphibians, tortoises and snakes, and terrestrial species will suffer higher mortalities than arboreal or burrowing species. Volant species (birds and bats) will suffer less mortality, except where important breeding or roosting sites are lost or migration routes disrupted.

Impact 1: Loss of Amphibian Diversity

Cause and Comment

Amphibians are the least specious group of terrestrial vertebrates in the project area. However, frogs, along with bats and lizards are important predators of insect pests. Myburgh & Nevill (2003) noted that in 1996 blackflies (particularly *Simulium chutteri*) caused R88 million damages per annum in the middle and lower Orange River. Due to habitat loss and mortalities directly associated with specific project actions, a loss of amphibian diversity will probably occur. Amphibian mortalities will occur during all phases (construction and operation) but will be most significant in association with habitat loss, particularly of wetlands. The Marbled Rubber Frog (*Phrynomantis annectans*) requires temporary water bodies for tadpole development, and breeding sites in the Power House region should be avoided.

All amphibians recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging wetlands, and limit river and stream crossings as far as possible. Associated infrastructure, particularly transport linkages, should avoid these areas with a buffer distance of at least 30 m.
- Wetlands must be protected and/or rehabilitated if damaged.
- Water quality and flow dynamics should be maintained.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Slight	May occur	**LOW**

Impact 2: Loss of Reptile Diversity

Cause and Comment

The project area probably contains a greater diversity of reptiles than was discovered during the survey for this assignment. Reptile populations, particularly snakes, are difficult to study. Increased human numbers associated with the development of the project will lead to increased mortality of reptiles, particularly tortoises and snakes, directly from road mortalities and human attitudes, as well as the losses from habitat loss and fragmentation.

All reptiles recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging pristine habitats, particularly in the riverine zone if possible.
- Protect abiotic habitats, such as rock outcrops, which shelter many reptile species.
- Curtail unnecessary night driving on roads during construction.
- Prohibit exploitation of sensitive reptiles, e.g. tortoises and chameleons by construction workers.
- Educate construction staff about the necessity of protecting snakes.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**

Impact 3: Loss of Bird Diversity

Cause and Comment

Birds are by far the most speciose vertebrate component in the region. Birds play important and diverse roles in ecosystem functioning (e.g. seed dispersal and trophic transfer) and maintenance of bird diversity is important to maintain viable habitats. Although a few birds are commensal, and can rapidly and successfully adapt to disturbed environments, the majority of birds are sensitive to disturbance and either migrate away from, or suffer greater mortality within, degraded habitats. However, because of their high mobility, birds are capable of rapidly re-colonising rehabilitated habitats, provided suitable microhabitats are available.

All birds recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Prior to commencing construction activities, conduct a survey of the affected area to identify active and potential breeding sites for Verreaux's Eagle, Lanner Falcon, Secretary bird, Kori Bustard, Ludwig's Bustard, and Black Stork, and, as far as possible, avoid disturbing them.
- Avoid clearing or damaging pristine habitats, particularly the riverine zone which shelters the highest avian diversity, if possible.
- Maintain habitat connectivity, particularly to protected areas, via habitat corridors.
- If possible, undertake habitat clearance during winter when birds are not breeding.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Probable	**MOD**
With Mitigation	Medium term	Localised	Slight	May occur	**LOW**

Impact 4: Loss of Mammal Diversity

Cause and Comment

The long history of human settlement, associated with subsistence and later commercial farming, has greatly reduced the presence of large mammals in the region. A number of large ruminants previously eliminated in the region have been re-introduced, whilst several large predators (e.g. leopard and brown hyena) have probably increased in number during the period of management of the Riemvasmaak property by the AFNP. The maintenance of these, as well as that of the small mammal diversity, depends on continued conservation management and the maintenance of habitat corridors and habitat diversity. All mammals recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation measures

- Avoid clearing or damaging pristine habitats where possible.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small mammals, including bats.
- Maintain protection of the existing mammal fauna from human impact, particularly persecution and illegal hunting.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW**

Impact 5: Loss of Species of Conservation Concern

Cause and comment

Numerous birds, reptiles and mammal species are either endemic to the region or are of conservation concern. Two characteristic reptiles, the Augrabies Flat Lizard and Augrabies thick-toed Gecko, are charismatic Near Endemics, whilst the Marbled Rubber Frog is a habitat specialist with only a marginal presence in South Africa.

Fourteen of the possible 247 bird species in the region are threatened or near threatened globally or regionally. The most significant avian Species of Conservation Concern (SCC) recorded on site, either during the faunal survey or elsewhere, include Ludwig's Bustard (EN), Secretary Bird (VU) and Black Harrier (VU). Fifteen bird species are regional or biome endemics.

Of the 72 terrestrial mammal species which may occur on site, only one is threatened (Hartmann's Mountain Zebra, VU), whilst another was reintroduced but has been relocated (Hook-lipped Rhinoceros, CR), and another may be present (Small Spotted Cat, VU). A number of other mammals are Near Threatened (Dassie Rat, Honey Badger and Brown Hyena), but no species are Endemic or Near Endemic to the region.

All SSCs recorded on, or likely to occur on the Riemvasmaak project area also occur in the AFNP, where they remain fully protected.

Mitigation and management

- Avoid clearing or damaging pristine habitats.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors.
- Protect abiotic habitats, such as rock outcrops, which shelter many small faunal species,

including reptiles and bats.

- The design of project structures and transport linkages should avoid where possible sensitive habitat corridors, e.g. drainage lines and wetlands.
- Road designs should, where necessary and on the advice of a faunal specialist, incorporate underpasses and culverts that allow the movement of animals.
- Where possible the road traffic should be limited after dark, as much of the surviving fauna is nocturnal, e.g. bats, most snakes, small rodents, amphibians, etc.
- Vehicle speed should be limited to the lowest possible, and should not exceed 50km/h (off national, provincial and district roads).
- Drivers should be educated regarding their role in impacting on animals and the need to minimize collisions with animals at all times.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Probable	**MOD**
With Mitigation	Medium term	Study area	Slight	Probable	**LOW**

Issue 2: Habitat loss and fragmentation

Impact 1: Impacts on fauna due to habitat fragmentation and habitat loss

Cause and comment

Various components of the development will cause biodiversity loss directly or indirectly through fragmentation of viable habitats for the various faunal groups. This is usually a loss of vegetation (plant communities) that supply food or shelter, but may include abiotic features such as the loss of temporary wetlands, caves or rocky outcrops.

Impacts to sensitive habitats are highly probable and will be local and negative in nature, and occur over the long-term. The significance of these impacts may vary from low to high depending upon the local importance of the habitat and the particular fauna that it harbours.

The proposed transport linkages and associated infrastructure will all cause additional habitat loss and fragmentation, over and above the project footprint. The greatest impact on habitat loss and fragmentation will be associated with the haul roads, and less so with the proposed water conduit from the weir to the power house. The location of the proposed weir lies in a region of riverine habitat and Lower Gariep Alluvial vegetation, and access and construction of the weir should avoid, where possible, all riverine vegetation.

The most sensitive region will probably be the construction and rehabilitation of a haul road down the steep sides of the ‘Canyon Zone’ into the lower ‘palaeochannel’ in order to allow drilling of the horizontal outlet tunnel. As the descent into the lower ‘palaeochannel’ is very steep it may not be possible to fully rehabilitate this track, particularly as it may be required for access to the tunnel entrance during the operational phase. Two routes have been proposed, both traversing the walls of the Canyon zone below the ‘palaeofalls’. Option 2 is shorter and does not cross the ‘upper palaeochannel’ above the ‘palaeofalls’ and is thus the preferred option. However, the design and construction of these haul road options have not been detailed, and either option is likely to result in a permanent impact (in terms of the project life) that cannot be mitigated in a region highlighted as Sensitive in the internal AFNP Management Plan 2013-2023.

Mitigation and management

The negative impact of habitat loss associated with the development of the project cannot be fully

mitigated. However, the following can assist in reducing the severity of the impact:

- All specific project actions associated with construction, access roads, borrow pits and cut-and-fill construction must avoid sensitive habitats as far as is practicable.
- Natural drainage channels should be maintained, and steps must be taken to ensure that construction activities do not cause silt loads into rivers, streams and wetlands to increase.
- Avoid clearing or damaging pristine habitats.
- Maintain habitat connectivity, particularly to intact habitats, via habitat corridors. The excavation of the water conduit route will result in a linear impact, and this should be undertaken in sections. This will allow faunal migration (e.g. for water access) across rehabilitated sections before construction begins on adjacent sections.
- Protect abiotic habitats, such as rock outcrops, which shelter many small faunal species, including reptiles and bats.
- The design of project structures and transport linkages should avoid where possible sensitive habitat corridors, e.g. drainage lines and wetlands.
- Mitigation of the impact entails protection and where necessary, rehabilitation of adjacent habitats as an environmental offset particularly wetland and riparian habitats.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	Localised	Very severe	Definite	**VERY HIGH**
With Mitigation	Permanent	Localised	Moderate	Probable	**MOD**

Issue 3: Additional construction impacts on fauna

A significant and widespread impact results from increased traffic in the region. Roads are known to alter physical characteristics of the environment and through these impacts roads affect ecosystems, biological communities and species in numerous and different ways.

Impact 1: Ecological impacts from dust

Cause and comment

Increased dust levels are common during construction especially from habitat clearance and increased vehicular traffic. Short-term increased dust levels will accompany all land preparation associated with construction.

Mitigation and management

- As most access roads will be rehabilitated after the construction phase, the impact cannot be mitigated by hard paving. It is suggested that the area is watered down during high wind conditions.
- Vehicle speed should be limited to the lowest possible, and should not exceed 50km/h (off national, provincial and district roads).

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Slight	Definite	**LOW**
With Mitigation	Short term	Localised	Slight	Probable	**LOW**

Impact 2: Disruption to fauna from increased noise levels

Cause and comment

Construction and associated vehicle traffic will create noise pollution that can depress local populations of sensitive faunal groups. Animals differ in the degree to which they tolerate such disturbance, and noise can be expected to have potentially negative impacts on various faunal groups. Large breeding birds do not usually tolerate continuous disturbance. Increased noise and motor vibrations in wetlands may also impact amphibian breeding choruses, but these impacts will be localised and many amphibian species are surprisingly tolerant of vehicle noise. Noise pollution will occur during all phases (construction, operational, and de-commissioning /closure). Little mitigation is possible.

Mitigation and management

- Mitigation of this impact is difficult, but noise reduction measures should be implemented in all sensitive areas (e.g. adjacent to wetlands) at sensitive times (e.g. at night).
- A reduction of construction activities after dark should be considered. However, this mitigation measure is economically unfeasible and therefore it is unlikely to be implemented and hence the impact after mitigation remains of moderate significance.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Severe	Definite	**MOD**
With Mitigation	Short term	Study area	Moderate	Definite	**MOD**

Impact 3: Chemical Pollution

Cause and comment

Many faunal groups are sensitive to pollutants. Lead concentrations are higher in small terrestrial mammals collected alongside roads than in bats caught in the same areas. Frog diversity in ponds affected by pollution from road run-off is depressed and the accumulation of herbicides and their residues in adjacent wetlands can lead to developmental abnormalities in tadpoles and metamorphosing froglets and also masculinization of female frogs.

Pollution may result from periodic accidents, or from a slow, ongoing contamination. During the construction phase heavy mechanical equipment and vehicles will be present. The use of inflammable liquids such as diesel will probably result in periodic accidents. Heavy vehicle traffic is also associated with increased local pollution resulting from exhaust fumes, oil spillage and accumulation of rubber compounds from tyre wear. These pollutants can cause localised impacts.

Mitigation and management

- Storage facilities for chemicals, particularly diesel, should not be situated in regions subject to flooding.
- Such stores should be bunded so that in the event of spillage their contents are contained in the bunded areas for subsequent decontamination or removal offsite for safe disposal.
- The application of herbicides or insecticides to control plant growth or insect pests should be prohibited.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of		

			Impact		
Without Mitigation	Medium term	Study area	Moderate	Definite	**MOD**
With Mitigation	Medium term	Localised	Slight	Probable	**LOW**

7.3.5 Heritage

Impact: Potential impacts on graves

Cause and Comment, Mitigation

Besides the few known graves and single graveyard, there are a large number of features on the landscape that may be graves. This will need to be carefully assessed when final alignments and disturbance corridors are available and it is suggested that every stone feature of unknown function that will be disturbed should be tested by an archaeologist to see if it is a grave. The Riemvasmaak community members need to be made aware of this issue and should be requested to issue a statement indicating their wishes for the deceased should any such features turn out to be graves. By the time the remaining features are being tested (during the mitigation phase) it will be too late to reroute the development and the remains will have to be exhumed. In such instances a plan needs to be in place as to where/how the remains would be reinterred. It would also be helpful if, during subsequent planning of the development, the client was accompanied on site by community members such that any stone mounds that are known to be graves can be flagged and protected without further disturbance.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Severe	Probable	**High**
With Mitigation	Long term	Localised	Moderate	Probable	**Moderate**

Impact: Potential impact on the cultural landscape

Cause and Comment, Mitigation

The cultural landscape here is not deemed highly significant for two reasons. One is that it is not very old and the other is that the community that created it has given its permission for the proposed development to go ahead through the areas once inhabited by them and their predecessors. In terms of mitigation, it is desirable that the proposed development attempt to avoid all the main historical features (like house ruins and large collections of stone features) in order to try to retain the cultural landscape in as intact a form as possible, but it is acknowledged that many of the smaller – and often isolated – features make very little contribution to the cultural landscape and could be removed (subject to testing for graves if appropriate). Known graves, or stone cairns that are believed could be graves, that will not be directly impacted by any infrastructure should be fenced around before construction activities commence to protect them from damage. Besides avoidance where possible, no other mitigation is suggested for the cultural landscape.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Moderate	Definite	**Moderate**

With Mitigation	Long term	Localised	Low	Probable	**Low**

Impact: Potential impact on the heritage of the AFNP

Cause and Comment, Mitigation

This impact is largely visual. As the developer will be installing the headrace and cables underground the visual impact will be mitigated entirely.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Moderate	Definite	**Moderate**
With Mitigation	Long term	Regional	Low	Probable	**Low**

7.3.6 Noise

Cause and comment

Generally, day-time noise levels associated with construction activities are limited to an area within 500 meters from the activity. The nature of the noise is generally more impulsive and in a sensitive natural environment animals will try to relocate further from the noise source. Sources of potential noise impact during construction may include, *inter alia*, construction activities including construction and or upgrade of access roads, laying of concrete foundations and other concrete making activities, installation of power chambers, use of equipment required to complete the construction and blasting, which may be a required during construction of the weir and headrace, and will be required for construction of power chamber and tailrace tunnel. The sound intensity from blasting for the wholly underground structures will, however, be significantly attenuated by the depth of rock cover above them.

Mitigation Measures

To minimize this noise risk the following mitigation is proposed:

- Make use of the smallest available equipment for the task;
- Notify potentially sensitive receptors about work to take place at least 2 days before the activity in their vicinity (within 500 metres) is to start. The following information is to be presented in writing:
  - Description of Activity to take place;
  - Estimated duration of activity;
  - Working hours;
  - Contact details of responsible party.
- Ensure that all equipment is maintained and fitted with the required noise abatement equipment;
- When any noise complaints are received, noise monitoring should be conducted at the complainant, followed by feedback regarding noise levels measured;
- The construction crew must abide by the local by-laws regarding noise, and if no local by-laws exist comply with “Draft model air quality management by-laws for adoption and adaptation by municipalities, GN 964 of 2009” (section 2.6);
- Where possible construction work should be undertaken during normal working hours (06H00 – 18H00), from Monday to Saturday; If agreements can be reached (in writing) with all the surrounding (within a 1,000 distance) potentially sensitive receptors, these working hours can be extended.

Significance Statement

Due to the temporary nature of construction related noises, as well as the fact that this will (unless arrangements have been made to extend working hours for certain activities) be taking place during the day when other sounds generally mask external noises, construction noises associated with this development should have a noise impact of low significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short-term	Study area	Moderate	Probable	**MODERATE**
With Mitigation	Short-term	Study area	Slight	May occur	**LOW**

7.3.7 Socio-economics and Tourism

Issue 1: Land Acquisition

Although the project will not lead to any permanent loss of land within 498/1 and Remaining Extent of 497, there will be permanent land loss associated with the construction and operation of the substation on private land adjacent to the park.

The following impacts are discussed under this issue:
- Impact 1.1: Permanent Land Loss;
- Impact 1.2: Temporary Disruption to Farming Activities.

Impact 1.1: Land Loss

Cause and Comment

As a result of the proposed project, there will be no permanent loss of land experienced by SANParks or the RCT. However, there will be a permanent loss of land associated with the substation to be constructed on private land adjacent to the AFNP. The maximum footprint of the substation will be 50x50m. The proposed site is not currently being used for any economic activity and, therefore, there should be no significant financial loss as a result of the loss of land.

Mitigation and management

The following mitigation measures apply:
I. There should be sufficient consultation with the affected landowners;
II. Landowners should be compensated for any permanent loss at market value;
III. Landowners should be compensated for any temporary loss to land.

Significance Statement

With mitigation measures, the severity of the impact will be slight. The overall impact will be of low negative significance. Should no mitigation measure be in place, the severity of the impact will be moderate, however the overall significance should remain low negative.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Localised	Moderate	Definite	**LOW -**
With Mitigation	Short-Term	Localised	Slight	Definite	**LOW -**

Impact 1.2: Temporary Disruption to Farming Activities

Cause and Comment

Overhead 132kV transmission lines will be required to evacuate power from either the proposed substation or, alternatively, directly from the hydro power station (the transmission lines will be under ground until the boundary of 497/0) to the Renosterkop Substation. The approximate length of the transmission lines will be 16km. From aerial imagery and observations during fieldwork, it is evident that the majority of the proposed alignment is through land not currently under cultivation and without existing transmission line infrastructure. There is, however, a section of approximately 1.3km where the proposed route will go through land used for grape cultivation. During construction, there will be a temporary disruption to farming activities in this area. However, with mitigation measures, no losses should be incurred.

Mitigation Measures

The following mitigation measures are provided:

I. Ensure there is sufficient consultation with affected landowners;
II. Ensure that affected landowners are informed well in advance prior to any construction taking place on their land;
III. Endeavour to conduct construction activities associated with transmission lines out of season and not during peak growing or harvesting time so that disruptions are kept to a minimum;
IV. Ensure that landowners are compensated for any temporary loss to land and/or damages to infrastructure or crops caused during the construction process.

Significance Statement

With mitigation measures, this impact will have a low overall significance. The reason for this is the fact that the impact's severity would be slight and short-term. Without mitigation measures, this impact will remain a low overall significance, although the severity of this impact would in all probability be moderate.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Localised	Moderate	Definite	**LOW -**
With Mitigation	Short-Term	Localised	Slight	Definite	**LOW -**

Issue 2: Local Economic Development

The project will certainly stimulate Local Economic Development (LED) for many reasons. The first reason is a significant amount of temporary employment opportunities, followed by the fact that, in accordance with the REIPPP programme, all communities within a 50km radius of the project should benefit from the project. The Riemvasmaak Community Development Trust will have shareholding and receive dividend income. The project should also stimulate the development of Small, Medium and Micro Enterprises (SMMEs), whilst it is also believed that the project could even stimulate tourism to some degree.

The following four impacts are discussed under this section:

- Impact 2.1: Employment Opportunities;
- Impact 2.2: Stimulating Small, Medium and Micro Enterprises;
- Impact 2.3: Increase in Informal Traders;

- Impact 2.4: Tourism.

Impact 2.1: Employment Opportunities

Cause and Comment

During the construction phase, between 150 and 200 temporary jobs will be created for a duration of about three years. Of these, approximately 75% will be skilled positions, whereas 25% will be unskilled workers. This is a significant impact, given the high levels of unemployment in the region and the high expectations of employment opportunities on the project.

Project Enhancement Measures

The following enhancement measures are proposed:

I. A local Community Liaison Officer (CLO) should be appointed in order to mediate between the employer and the employees;
II. Employment opportunities should be provided to the Riemvasmaak Community Trust (RCT) and the broader community in terms of the REIPPP;
III. Ensure that the requirements set out by the REIPPP process are strictly adhered to;
IV. Consult with local government and community organisations regarding the hiring of local labour;
V. Endeavour to train and employ local people as far as is feasibly possible;
VI. Embark on skills development training for potential employees from local communities;
VII. Maintain clear lines of communication between the project proponent and local communities regarding employment opportunities.

Significance Statement

With appropriate enhancement, the project will have a high positive impact in terms of providing employment opportunities. The reason for this is the definite likelihood of this impact, which should be experienced at a regional level. With few enhancement measures, the benefit of employment provision will only be moderate positive. The reason for this is the fact that the risk of this impact is definite, although the severity of it should be moderate.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Regional	Moderate beneficial	Definite	**MOD +**
With Mitigation	Short-Term	Regional	Beneficial	Definite	**HIGH +**

Impact 2.2: Stimulating Small, Medium and Micro Enterprises

Cause and Comment

The project will create opportunities for Small, Medium and Micro Enterprises (SMMEs) in the region. Services which could be provided by local SMMEs may include road maintenance, removal of spoil material, provision of accommodation, provision of meals, etc.

Project Enhancement Measures

The following enhancement measures are proposed:

I. Identify which services could be supplied by local SMMEs as contractors;
II. In consultation with local government and community organisation, identify SMMEs and contractors who could supply the required services;
III. Endeavour to employ local contractors and SMMEs as far as is feasibly possible.

Significance Statement

With appropriate enhancement, the project will have a moderate positive impact on the stimulation of SMMEs. The reason for this rating is the fact that the impact should be short-term and slight. With no enhancement measures, the project will have a low positive impact on the stimulation of SMMEs. The reason for this rating is the fact that the impact should be short-term and slight.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Enhancement	Short-Term	Regional	Slight	Probable	**LOW +**
With Enhancement	Short-Term	Regional	Moderate beneficial	Probable	**MOD +**

Impact 2.3: Increase in Informal Traders

Cause and Comment

Although it is unlikely that informal traders will be present at the construction site, opportunities will exist for informal traders in the vicinity of where the construction team is accommodated. This will lead to a temporary source of income for local households and indirectly increase money in the local economy, albeit by a small amount.

Project Enhancement Measures

The following enhancement measures are proposed:

I. In conjunction with the local municipality, ensure that refuse disposal facilities are available.

Significance Statement

The impact is low positive, as its risk is unlikely.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Enhancement	Short-Term	Local	Slight beneficial	Unlikely	**LOW +**
With Enhancement	Short-Term	Local	Moderate beneficial	Unlikely	**LOW +**

Impact 2.4: Tourism

Cause and Comment

It should be noted that the Augrabies Falls is a significant tourism destination within the Northern Cape. Comparison of numbers of visitors to the park between 2009 and 2013 showed that, although there was a large influx of visitors during the very large floods of 2010 and 20111, the number of visitors to the park is not solely determined by the volume of water over the falls. The falls may not be the primary reason for tourists being in the general area, but many tourists pass through the area en route to Namaqualand or Namibia, and if they are in the area they invariably visit the AFNP. The construction activities of the project might have an effect on noise, visual, dust or sense of place.

Mitigation Measures

The following mitigation measures are proposed:

I. Ensure that all components of the project which may be visible are designed in such a manner so as to reduce the visual impact;
II. Avoid construction after daylight hours as far as possible;
III. Advanced warning should be provided to landowners and the AFNP prior to any blasting taking place during construction;
IV. Prior to heavy duty vehicles accessing the project site, dust suppression techniques should be used on the access road;
V. Ensure that strict speed limits are adhered to by all project vehicles to reduce dust;
VI. Ensure that the proposed plans regarding minimum flow volumes reaching Augrabies Falls are abided by.

Significance Statement

With mitigation measures, the impact will have a low negative significance, as it should be short-term and very local in scale. Without mitigation measures the impact will be moderate negative. The reason for this is the fact that the severity of the impact would be moderate.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Local	Moderate	Probable	**MOD -**
With Mitigation	Short-Term	Local	Slight	Probable	**LOW -**

Issue 3: Health and Safety

The project will have an effect on the Project-Affected Communities (PACs) in terms of general health and safety. The following impacts are discussed in this section:

- Impact 3.1: Spread of Diseases;
- Impact 3.2: Increased Road Accidents;
- Impact 3.3: Increase in Dust;
- Impact 3.4: Fire Hazard;
- Impact 3.5: Increased Criminal Activities.

Impact 3.1: Spread of Diseases

Cause and Comment

As the majority of labour will be sourced from the surrounding communities, the spread of diseases should be limited as the number of outside workers should be reduced. Still, job-seekers are expected, who can contribute to an increased likelihood of spread of disease. While the impact is not thought to be significant, it should be taken into consideration and the necessary mitigation measures followed.

The drivers of trucks carrying construction materials may contribute to the spread of HIV / AIDS. While it has not been confirmed where the required construction materials will be sourced, it is likely that there will be a significant increase in truck traffic through towns such as Augrabies, Marchand and Kakamas as well as other towns en route to the project site.

Mitigation Measures

The following mitigation measures are proposed:

I. An HIV/AIDS awareness/education component should be included in the induction programme for all personnel working on the proposed project;
II. Ensure there is easy access to HIV/AIDS-related information and condoms for all workers involved with the proposed project.

Significance Statement

With mitigation measures, the impact will have a low negative significance, as the impact is short-term and slight. Without mitigation measures, the impact remains low negative, as the impact is short-term and slight.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Regional	Slight	Definite	**LOW -**
With Mitigation	Short-Term	Regional	Slight	Probable	**LOW -**

Impact 3.2: Increased Road Accidents

Cause and Comment

An anticipated increase in vehicle traffic along the access road is significant. It is assumed that there will be a significant increase in the volume of traffic on the access road linking the N14 to the study site. The current road is a gravel/sand road, which is not heavily utilised. This could lead to an increase in road accidents.

A section of the road is currently used by people travelling to and from the Riemvasmaak Community as well as by farmers and farm workers living and working in the area. The road has not been designed to take high volumes of traffic or for use by heavy duty vehicles required for the transportation of large pieces of equipment such as pipes, generators, etc. associated with the project. In addition, the road is often used by slow moving farm machinery such as tractors as well as by pedestrians

Mitigation Measures

The following mitigation measures are proposed:

I. Considering the remote nature of the project site and the limited access to healthcare facilities, it is important that emergency healthcare facilities are available on site and that there is a suitable evacuation plan in the event of serious and/or life threatening injuries;
II. Develop a traffic management plan or include a traffic management section within the Environmental Management Programme (EMPr), including maximum speed limits dependent on the type of vehicle;
III. Ensure that the road is maintained in a good condition at all times and is not allowed to deteriorate;
IV. Prior to construction commencing, ensure that the road is widened to a suitable width;
V. All drivers should be briefed regarding the traffic management plan.

Significance Statement

With mitigation measures, the impact will have a low negative impact, as the impact is short-term and slight. Without mitigation measures the impact will be moderate negative, as the likelihood of the impact will change from being probable to definite.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Regional	Moderate	Definite	**MOD -**
With Mitigation	Short-Term	Regional	Slight	Probable	**LOW -**

Impact 3.3: Increase in Dust

Cause and Comment

During construction, it is likely that there will be a significant amount of dust generated through various activities, which, in turn, will have a negative impact on the surrounding environment. Some of these activities include, but are not limited to:

- Soil/sand stockpiles;
- Trenching activities for the laying of underground water conduit and transmission lines;
- Blasting;
- Windblown dust;
- Increased vehicle traffic along the access road (the current road is a gravel/sand road).

Mitigation Measures

The following mitigation measures are proposed:

I. Dust on the construction sites should be controlled by means of water spray vehicles;
II. Dust on access roads should be controlled by means of water spray vehicles, especially prior to movement of heavy duty or haulage vehicles;
III. Farmers should be consulted on a case by case basis to discuss likely impacts and to determine if preventative measures are required;
IV. Prior to heavy duty vehicle accessing the project site, dust suppression techniques should be used on the access road;
V. Ensure that speed limits are strictly adhered to by all project vehicles to reduce dust.

Significance Statement

With mitigation measures, the impact will have a low negative significance. Without mitigation measures, the impact will be low negative.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Localised	Slight	Definite	**LOW -**
With Mitigation	Short-Term	Localised	Slight	Definite	**LOW -**

Impact 3.4: Fire Hazard

Cause and Comment

Construction activities are often associated with fire risks. These could result from exposed fires for warmth, cigarettes, burning of firebreaks, and the use of flammable liquids. The dry and hot conditions associated with the project site make the area particularly vulnerable to fire. Uncontrolled fires may lead to the loss of wild game in the AFNP, as well as undesirable visual impacts for tourists in the AFNP.

Mitigation Measures

The following mitigation measures are proposed:

I. Ensure that no fires are allowed on site.

Significance Statement

With mitigation measures, the impact will have a low negative impact, as it is short-term and the likelihood slight. Without mitigation measures, the impact will be moderate negative. This is because the impact should be moderate.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Localised	Moderate	Definite	**MOD -**
With Mitigation	Short-Term	Localised	Slight	Definite	**LOW -**

Impact 3.5: Increased Criminal Activity

Cause and Comment

Prior to and during construction, the in-migration of job-seekers is likely to bring with them criminal opportunists. Although the relatively remote nature of the project site will somewhat limit the likelihood of criminal activities in the direct vicinity of the project site, it should be noted that one of the issues which came out of discussions with Riemvasmaak community members is the need to ensure that there is no poaching of game in and around the AFNP and the land owned by the Riemvasmaak Community Trust.

Mitigation Measures

The following mitigation measures are proposed:

I. Housing the construction workers within Kakamas town should greatly reduce the possibility of an increase of criminal activities;
II. Construction teams should be clearly identified by wearing uniforms and/or wearing identification cards that should be exhibited in a visible place on their body;
III. Instant dismissal and prosecution of any staff caught in criminal activities of any kind (including the poaching of plants and animals);
IV. Establishment of a Community Management and Monitoring Committee (CMMC) to act as a communication link between the local community and the project proponent, in this case, in relation to criminal activity;
V. Inform local law enforcement agencies of the possibilities of increased criminal activity in the area.

Significance Statement

With mitigation measures, the impact should have a low negative impact, as it is short-term with a probable risk. Without mitigation measures, the impact should be low negative as it is short-term with a probable risk.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Regional	Moderate	Probable	**LOW -**
With Mitigation	Short-Term	Regional	Slight	Probable	**LOW -**

Issue 4: Social Services

With an influx of workers and job-seekers into the area, the project could potentially increase the pressure on existing social services. The impact discussed under this issue is thus an increase in pressure on existing social services.

Impact 4.1: Increased pressure on existing social infrastructure

Cause and Comment

Construction workers are to be housed in formal accommodation either in Kakamas town or between Kakamas and the project site. However, there is the possibility that a temporary influx of construction workers into these towns or the surrounding area could place increased pressure on the existing service infrastructure, including water and electricity supply, and sanitation systems. In addition, road infrastructure is also likely to be negatively impacted as a result of the project.

Mitigation Measures

The following mitigation measures are proposed:

I. If feasible, excess spoil excavated as part of the proposed project be donated to the provincial roads authority or the district and local municipalities to use for the upgrading of roads in the area. This material can, therefore, be used to upgrade and/or maintain the gravel roads that might be negatively affected by the proposed project;
II. Upgrading and maintenance of road infrastructure before construction;
III. Establishment of a Community Management and Monitoring Committee to act as a communication link between the local community and the project proponent, in this case, in relation to damaged infrastructure.

Significance Statement

With mitigation measures, the impact will have a low negative impact, as it is short-term and slight. Without mitigation measures, the impact will be moderate negative, as it is short-term and moderate.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Construction Phase					
Without Mitigation	Short-Term	Regional	Moderate	Unlikely	**MOD -**
With Mitigation	Short-Term	Regional	Slight	Unlikely	**LOW -**

7.3.8 Visual

Impact: The anticipated visual impact of construction on sensitive visual receptors in close proximity to the infrastructure or activities.

Cause and comment

The anticipated visual impact of the facility on the regional visual quality, and by implication on the sense of place of the region, is expected to be of moderate significance, both before and after the implementation of mitigation measures, during the construction phase of the project.

Mitigation and management

- Plan all infrastructure in such a way and in such a location that clearing of vegetation is minimised. Consolidate infrastructure and make use of already disturbed sites rather than pristine areas wherever possible.
- Mitigation of visual impacts associated with the construction of access roads is possible through the use of existing roads wherever possible. Where new roads are required to be constructed, these should be planned carefully, taking due cognisance of the local topography.
- Roads should be laid out along the contour wherever possible, and should have adequate drainage structures in place to prevent potential erosion.
- Access roads, which are not required post-construction, should be ripped and actively rehabilitated. It should be taken into consideration that this vegetation type would take years (if ever) to recover to its former status if left by itself, thus rehabilitation of vegetation should be planned properly and a management programme followed to ensure optimal rehabilitation.
- For potentially visible above-ground structures, implement materials and architectural forms that utilise and compliment the natural rock and soil colour and texture. This can greatly reduce the visibility of the proposed structures.
- Mitigation of visual impacts associated with the construction phase, albeit temporary, entails proper planning, management and rehabilitation of all construction sites. Construction should be managed according to the following principles:
    - Ensure that vegetation is not unnecessarily cleared or removed during the construction period.
    - Reduce the construction period through careful logistical planning and productive implementation of resources.
    - Plan the locations of lay-down areas and any potential temporary construction camps so as to minimise the need to clear vegetation.
    - Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.
    - Ensure that rubble, litter, and disused construction materials are appropriately stored (if not removed daily) and then disposed regularly at licensed waste facilities.
    - Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent).
    - Restrict construction activities to daylight hours (as far as possible) in order to negate or reduce the visual impacts associated with lighting.
    - Ensure that all infrastructure and the site and general surrounds are maintained and kept neat.
    - Rehabilitate all disturbed areas, construction areas, roads, slopes etc. immediately after the completion of construction works. Due to the sensitive nature of the vegetation, an ecologist should be consulted to assist or give input into rehabilitation specifications.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Moderate	Probable	**MODERATE**
With Mitigation	Short term	Study area	Moderate	Probable	**MODERATE**

7.3.9 Seismicity

Cause and comment

The level of seismic activity recorded during the currency of the ongoing swarm has been relatively low, with 16 events with magnitude of between 4.0 and 5.0 (Richter scale) and relatively low levels of horizontal acceleration being recorded up to December 2014. Nevertheless, seismic events during construction may result in damage to structures as they are being built unless they are designed to resist the effects of such events.

Mitigation and management

Structures must be designed to resist seismic events of the magnitude and intensity expected in the general area, and recorded during recent events, including

- Reinforcement design should follow good practice for earthquake resistance as detailed in SANS 10160-4:2011 (Basis of Structural Design and Actions for Buildings and Industrial Structures — Part 4: Seismic Actions and General Requirements for Building).
- Culverts must be designed with flexible joints between sections.
- Culverts must be bedded on and backfilled with granular material.
- The design of the power chamber must take account of the integrity of the parent rock, and include measures such as concrete spraying and rock bolting as appropriate to ensure structural integrity.

Significance statement

The overall significance is Low without and with mitigation, but mitigation measures reduces the severity from Moderate to Slight and the Probability from Probable to Unlikely.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**

7.3.10 Economic

Impact 1: Increased dust nuisance

Cause and Comment

Increased traffic on road during construction will result in increased generation of fugitive dust, which is problematic for grape growers and open-air raisin drying, especially during windy conditions.

Mitigation and Management

- Sprinkler system.
- Influence district road authority to improve public road surface and maintenance, preferably sealing the road.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Localised	Moderate	Definite	**LOW -**
With Mitigation	Short term	Localised	Slight	Probable	**LOW -**

Impact 2: Impacts on public roads

Cause and Comment

Increased heavy vehicle traffic on the public road to the site, north side of the river, which is already in poor condition, will cause additional degradation.

Mitigation and Management

Support district road authority to improve road surface and maintenance, preferably sealing the wearing surface.

Significance of statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Regional	Severe	Definite	**MODERATE -**
With Mitigation	Short term	Localised	Slight	Probable	**LOW -**

Impact 3: Increased tourism bed-nights

Cause and Comment

Skilled and professional persons working on the project will require accommodation.

Mitigation and Management

Not applicable – no appropriate enhancement measures.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Moderate Beneficial	Definite	**MODERATE +**
With Mitigation					**N / A**

Impact 4: Increased Retail/SME Turnover

Cause and Comment

Employment on the project will lead to increased expenditure in the local retail sector, including small and informal enterprises.

Mitigation and Management

Ensure that project services are contracted to local small enterprises wherever possible.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Regional	Slight Beneficial	Definite	**MODERATE +**
With Mitigation	Short term	Regional	Moderate Beneficial	Definite	**MODERATE +**

Impact 5: Increased Employment

Cause and Comment

Project will provide an estimated 150-200 jobs.

Mitigation and Management

Maximise employment of local residents.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Regional	Slight Beneficial	Definite	**MODERATE +**
With Mitigation	Short term	Regional	Moderate Beneficial	Definite	**MODERATE +**

7.4 Operation Phase Impacts

7.4.1 Agriculture

The agricultural impacts and mitigation measures applicable to the operations phase are not different from those of the construction phase.

7.4.2 Aquatic Ecology

Impact 1: Transformation of aquatic habitat upstream of the weir

Cause and comment

The diversion weir will act as an impounding structure that will reduce the flow velocity of water through the watercourse, leading to transformation of the aquatic habitat, leading to transformation of the aquatic species community structures.

The diversion weir is not designed to be an impounding structure, but rather an offtake weir, meaning that impounding of the water will be minimal, creating an insignificant inundation upstream of the site.

Mitigation and management

Active management of the scheme is required to ensure that flow volume to the main channel is never reduced below 30 m^3/s as a consequence of the scheme. It is acknowledged that flow rates lower than this could occur due to management of upstream impoundments, upstream abstractions or natural low season flows.

Significance statement

The weir is a fixed, free-flow structure without gates, and the extent of the impoundment depends on the flow rate of the river. There are no practical mitigation measures, and the significance remains unchanged at Low.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	The diversion weir will act as an impounding structure that will reduce the flow velocity of water through the watercourse, leading to transformation of the aquatic habitat, leading to transformation of the aquatic species community structures	2	4	2	3	1	2	High	**20 Low**	2	4	2	3	1	2	High	**20 Low**

Impact 2: Barrier to instream migration

Cause and comment

The diversion weir will act as a migratory barrier that will impede freedom of movement of migrating aquatic biota.

Migratory freedom is required to allow for aquatic biota to exploit available habitat for various reasons, including feeding, breeding and spawning. Blocking migratory freedom deprives various species of resources, habitat and dispersal.

This diversion weir, if found to block migrating aquatic biota, will delimit only a small section of the river before the natural and absolute barrier of the Augrabies Falls is encountered. The significance of this is therefore thought to be relatively small.

Mitigation and management

Analysis of the weir design, drown-out potential, and extent that it will pose as a migratory barrier should be explored and the provision for a fishway should be considered if it is found that one is required.

Note: It is probable that DWS will require a fishway as a matter of good practice

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Duration,

Ecosystem impacts and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	The diversion weir will act as a migratory barrier that will impede freedom of movement of migrating aquatic biota	2	4	1	3	1	2	High	**18 Low**	2	1	1	1	4	1	High	**1 Low**

Impact 3: Creation of artificial habitat in episodic watercourses

Cause and comment

Discharge of water into an otherwise seasonally dry watercourse will create artificial habitat and potentially disorientate migrating organisms.

The transferring canal/headrace will discharge into a balancing dam (forebay/head pond), which then flows through the powerhouse/turbines. The outfall from the turbines is into a seasonally dry section of the river; therefore it will create artificial conditions that may disorientate migrating biota within the localized area. Fish would utilise this area for spawning purposes if they encounter an impassable migratory barrier and cannot locate an alternative (i.e. swim further upstream to locate more suitable breeding habitat). This is thought to be of limited significance as, for the vast majority of the time, the greater proportion of flow will be through the main channel, which will mean that fish will orientate themselves to follow the stronger current. The Augrabies Falls already poses an impassable barrier close to the site, meaning that fish have had to historically accommodate this feature. Flow into this side channel may also be a positive impacting feature as it will expand the available habitat within the local river reach.

Mitigation and management

This feature is not something that can readily be mitigated once the scheme is in operation.
Active management of the scheme is required to ensure that flow volume to the main channel is never reduced below 30 m^3/s as a consequence of the operations of the hydro power scheme. This will minimise the impact on the mainstem channel, and ensure that the mainstem is the dominant instream influence on fish movement.

Significance statement

There are no practical mitigation measures, and the significance remains unchanged at Low.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Discharge of water into an otherwise seasonally dry watercourse will create artificial habitat and potentially disorientate migrating organisms	2	4	1	3	1	2	High	**18 Low**	2	4	1	3	1	2	High	**18 Low**

Impact 4: Contamination of surface water features

Cause and comment

Contamination of surface water features by, for instance hydrocarbons such as fuel and oil, can lead to loss of sensitive biota.

Mitigation and management

- Containment of effluents and prevention of accidental discharges to ensure that contaminants do not reach the surface waters will greatly reduce this impact.
- Strict management procedures will ensure correct operational procedures, which will, in turn, protect the surface water resources from contamination.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Spatial Extent, Duration, Intensity, Ecosystem Impacts and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance *before* mitigation**								Environmental significance *after* mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Contamination of surface water features leading to loss of sensitive biota.	2	4	5	4	2	4	High	**52 Low**	1	1	1	2	3	2	High	**4 Low**

Impact 5: Erosion of the watercourse at outfall sites (tailrace)

Cause and comment

Long-term erosion of the watercourse at the outfall sites – the tailrace outlet and the overflow spillway from the headpond - could occur if the outfalls are not properly designed to break and aerate discharges. The impact is thought to be minimal as the outfall region is dominated by granite bedrock.

Mitigation and management

Careful planning and design should be implemented to abate the scouring effects of the release of high velocity water.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Spatial Extent, Duration, Intensity, Ecosystem Impacts and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance *before* mitigation**								Environmental significance *after* mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Aquatic habitat features	Erosion of the watercourse at outfall sites	2	4	5	4	2	4	High	**52**	1	1	1	2	3	2	High	**4**

Impact 6: Contamination of surface water features

Cause and comment

Contamination of surface waters through accidental spillages can lead to loss of aquatic biodiversity.

Mitigation and management

- Containment of accidental discharges/spillages to ensure that contaminants do not reach the surface waters will greatly reduce this impact.
- Strict management procedures will ensure correct operational procedures, which will, in turn, protect the surface water resources from contamination.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Spatial Extent, Duration, Intensity, Ecosystem Impacts and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Water quality impacts	Contamination of surface waters through accidental spillages leading to loss of aquatic biodiversity.	2	4	1	4	1	3	High	**30 Low**	1	1	1	2	2	2	High	**6 Low**

Impact 7: Exotic vegetation encroachment

Cause and comment

Exotic vegetation encroachment can follow soil disturbances because of the reactivation of previously dormant seed banks.

Mitigation and management

The rehabilitated areas and adjacent watercourses must be regularly monitored for at least four years after completion of rehabilitation, and steps taken to identify, remove and follow up on any infestations of alien and exotic vegetation discovered.

Significance statement

Significance without and with mitigation is Low, but mitigation measures reduce Spatial Extent, Duration, Intensity, Ecosystem Impacts and Probability, and increase Reversibility.

Potential environ impact	Project activity or issue	Environmental significance ***before*** mitigation**								Environmental significance ***after*** mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Biodiversity impacts	Exotic vegetation encroachment following soil disturbances	2	4	1	2	2	4	High	**28 Low**	1	1	1	1	4	2	High	**0 Low**

Impact 8: Habitat transformation and sedimentation of aquatic habitats

Cause and comment

Soil erosion resulting from poorly-designed watercourse crossings of the headrace can lead to habitat transformation and ultimate sedimentation of aquatic habitats. This will lead to smothering of the aquatic habitat, ultimately displacing aquatic species.

Mitigation and management

Stormwater engineering needs to take into consideration the deposition of silts transported after rainfall events into the surface water resources.

Significance statement

Significance without mitigation is Moderate, but is reduced to Low by implementing mitigation measures, due to reduction in Spatial Scale, Duration, Intensity, Ecosystem Impacts and Probability, and increase in Reversibility.

Potential environ impact	Project activity or issue	Environmental significance *before* mitigation**								Environmental significance *after* mitigation**							
		S	D	I	E	R	P	Conf*	SR	S	D	I	E	R	P	Conf	SR
PRECONSTRUCTION & CONSTRUCTION PHASES																	
Soil erosion	Soil erosion resulting from poorly designed watercourse crossings of the transfer canal/water conduit leading to habitat transformation and ultimate siltation of the aquatic habitat.	2	4	3	4	1	4	High	48 Mod	1	1	1	2	2	2	High	6 Low

7.4.3 Vegetation

The impacts for the operations phase are the same as those identified for the construction phase, in addition to:

Impact: Impacts on the aesthetics of the project area as a conservation area

Cause and comment

The project area falls within land parcels that, although managed by SANParks, do not legally fall within a formally protected area. The presence of the infrastructure does not meet the land use planning tools proposed by SANParks, which is to maintain the natural state and aesthetic of the area. However, given the relatively small footprint of the infrastructure associated with the project, and the fact that most of it is located underground, it is unlikely that the project will be visually intrusive after the construction phase, nor is it likely that this development will prevent the conservation of this area as a future protected area. A number of parks throughout South Africa have roads, tracks and power lines running through them.

If the project infrastructure is located below ground for the duration of the operational phase, the expected impact on the area as a conservation area will be of moderate significance.

Mitigation

- During operation, the maintenance of the structures (e.g. the substation), the access roads, the power line servitude and other ancillary structures and infrastructure will ensure that the facility does not degrade, thus aggravating visual impact.
- Roads must be maintained to forego erosion and to suppress dust, and rehabilitated areas

must be monitored for rehabilitation failure. Remedial actions must be implemented as and when required.
- Monitor rehabilitated areas for rehabilitation failure, and implement remedial actions as and when required.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Moderate	Probable	**MODERATE**
With Mitigation	Long term	Study area	Slight	Probable	**LOW**

7.4.4 Fauna

It is assumed that all mitigatory measures proposed are implemented and that full rehabilitation of the main areas affected by construction is undertaken, particularly:
- that associated with the weir construction,
- the excavation of the headrace route,
- the headpond, and
- the transmission lines.

However, access roads will need to be maintained for maintenance and repair to the various components, particularly the weir, transmission lines and outlet tunnel.

Issue 1: Loss of Biodiversity

Impact 1: Loss of faunal biodiversity

Cause and comment

Impacts during the operation of the proposed project will vary for the different faunal groups. Amphibian diversity may be impacted by possible small scale, localized changes in water flow dynamics in the region of the water conduit. For some species, however, this will probably be offset by increased breeding habitat associated with the existence of the head pond and also increased water flow via the discharge tunnel into the lower 'palaeochannel'. Similarly, increased bird numbers and diversity can be expected in the more vegetated riverine habitats in the lower 'palaeochannel'. Both groups may be positively impacted during this phase. Mammals such as Cape Clawless Otter and Water Mongoose may increase in number in the lower 'palaeochannel' due to an increase in fish numbers and other small vertebrates that form their diet. Due to an increase in well-vegetated riverine habitats along the lower 'palaeochannel', changes in negative impacts on faunal diversity in the region can be expected to be self-mitigated.

Mitigation and Management
- Avoid clearing or damaging wetlands, and limit river and stream crossings as far as possible. Associated infrastructure, particularly transport linkages, should avoid these areas, including a buffer distance of 30 m.
- Maintenance of water quality and flow dynamics.
- Prohibit night driving on access roads during maintenance visits to the site.
- Eradicate or control alien plant encroachment, particularly aquatic aliens (e.g. *Phragmites* reeds) in the head pond and lower 'palaeochannel'.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Moderate	Probable	**LOW +**

Impact 2: Loss of Species of Conservation Concern (SCC)

Cause and comment

The primary impact on SSC will be mainly related to the section of above-ground power transmission, particularly the crossing of the Orange River to connect to the existing Eskom transmission network near Augrabies. Overhead Transmission lines form a well-documented threat to a number of threatened bird species. This results from two main impacts: electrocution from contact with live elements when birds nest or roost on the supporting pylons, and collisions with overhead power lines when in flight (Anderson 2002; Jenkins and Smallie 2009; Jenkins et al. 2010; 2011; 2013). The latter is particularly important for storks and bustards, which have limited frontal vision and so may not see power lines, even if they are marked (Martin and Shaw 2010). Collision rates on high voltage transmission lines in the De Aar area of the Karoo may exceed one Ludwig's Bustard per kilometre per year (Anderson 2002; Jenkins et al. 2011), and there is preliminary evidence for this level of mortality on transmission lines across the Karoo, indicating that the problem is widespread (Jenkins et al. 2011). It is estimated that such collisions alone are already enough to cause a rapid decline in the Ludwig's Bustard population and may increase in the future (Jenkins et al. 2011). Electrocutions on support pylons have been greatly reduced with new pylon designs. In fact, due to their use as roosting and nesting structures, well-designed pylons may even have a beneficial impact in arid regions by supplying roosting and nesting sites in areas where these are of limited availability.

Some mammals and ground-nesting birds are known to avoid habitats up to several kilometres from high-voltage power lines. Tyler et al. (2014) propose that ultraviolet discharges on power lines (‘standing corona’ along cables and irregular ‘corona flashes’ from insulators) are a possible cause of this avoidance.

Mitigation and Management

- Numerous pylon designs and transmission cable attachments (bird flappers) are available to reduce bird collisions and electrocutions (for an international review see: APLIC 2012; and Jenkins *et al*. 2013). Suitable design and warning attachments should be incorporated into the design of the above ground transmission network.
- Regular monitoring for bird mortalities along the transmission line should be included as part of the EMPr, to inform the placement of remedial bird flappers.

Significance Statement

a	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	**HIGH**
With Mitigation	Medium term	Study area	Moderate	Probable	**MOD**

Impact 3: Introduction of alien fauna

Cause and comment

The threat presented by alien invasive fauna is limited. Developments offer corridors for the introduction of alien species via roads associated with their construction and operation. Introduced urban rodent pests such as the house mouse (*Mus musculus*), house rat (*Rattus rattus*) and the Norwegian rat (*Rattus norvegicus*) are not recorded in the AFNP, but are likely to occur in adjacent populated areas. These species generally tend to survive alongside human habitation, and don't spread into natural areas.

The most widespread and common alien bird is the House Sparrow (*Passer domesticus*) which is now distributed almost worldwide. In addition, the European Starling (*Sturnus vulgaris*) is also an abundant introduced resident avian species. Neither was recorded on site. The most recent and active bird invasive in the Nama Karoo region is the Pied Crow (*Corvus splendens*), which is actively expanding its range in association with the greater availability from human structures of nesting sites in semi-arid regions. Increased food resources, via mortalities and prey visibility, are also afforded by roads.

As the operational phase of the project requires little road access and no on-site habitation the risk of alien fauna introduction is slight.

Mitigation and management

- The deliberate introduction of alien species should be prohibited, unless a full environmental assessment is undertaken and control methods for escapees detailed.
- Eradication programs of problem animals should be undertaken if needed and in consultation with conservation authorities.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Slight	Unlikely	**LOW**

Impact 4: Threats to animal movements

Cause and comment

Linear developments, such as roads and transmission lines, disrupt the movement of species within their normal home ranges or the seasonal movements of migratory species. Habitat fragmentation may require species to make long movements between patches of suitable habitat in search of mates, breeding sites or food. At such times they may suffer increased mortality, either directly from road vehicles, or from their natural predators due to increased exposure.

Reptiles and amphibians do not undertake long distance migrations, but both groups may undertake short seasonal movements. Many snakes undertake movements between winter hibernation sites and their summer foraging areas. Amphibians are known to experience the highest levels of mortalities associated with the presence of roads among vertebrates. This is mainly attributed to en masse seasonal migrations to and from their breeding sites. However, both toad species in the region, e.g. Guttural Toad and Raucous Toad, are not explosive breeders and mass migrations are not expected. Impacts on animal movements will be significant for all faunal groups. For amphibians this impact will be greatest where the road runs adjacent to wetlands suitable for breeding. It is an impact of high probability that will be negative due to increased mortality. It will be localised and occur over the long-term.

The Riemvasmaak Hydro Power project forms part of the expanding power generation capacity of Southern Africa. The project's power connection will be underground in the section from the power house to the weir region. This is beneficial as some large mammals and ground-nesting birds are known to avoid habitats up to several kilometres from high-voltage power lines. Tyler et al. (2014) propose that ultraviolet discharges on power lines ('standing corona' along cables and irregular 'corona flashes' from insulators) are the main cause of this avoidance. However, the rest of the line runs above ground and crosses the Orange River to connect to the existing Eskom transmission network near Augrabies. The Orange River forms an important flight path for many birds, particularly water birds moving along the Orange River (e.g. Black Stork, NT), or for birds migrating between important IBAs such as the Orange River Mouth Wetlands (IBA ZA030), the AFNP (IBA ZA022) and inland seasonal wetlands, e.g. Kamfers Dam, Kimberley (IBA ZA032), e.g. Greater and Lesser Flamingo (NT).

As noted earlier, overhead power lines form a well-documented threat to birds, particularly large threatened species such as raptors, storks and bustards. The nature of these threats and mitigatory measures are discussed under Impact 2 - Loss of Species of Conservation Concern, above.

Mitigation and management

- Numerous pylon designs and transmission cable attachments (bird flappers) are available to reduce bird collisions and electrocutions (for an international review see: APLIC 2012; and Jenkins *et al*. 2013). Suitable design and warning attachments should be incorporated into the design of the above ground transmission network.
- Regular monitoring for bird mortalities along the transmission line, and for road mortalities within the Riemvasmaak region should be included as part of the EMP to inform remedial mitigation measures.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Severe	Definite	**HIGH**
With Mitigation	Medium term	Study area	Moderate	Probable	**MOD**

Issue 2: Habitat Impacts

Impact 1: Impacts on fauna due to habitat fragmentation and habitat loss

No additional habitat loss or fragmentation will occur during the operational phase.

Cause and comment

The maintenance of some access roads to the power house and into the lower 'palaeochannel' will maintain habitat fragmentation generated during the construction phase.

Mitigation and management

Access routes for maintenance and repair should be the minimum required for intermittent access. Material required for road maintenance should be sourced as far as possible from project-related surplus excavated material.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Moderate	Probable	**LOW**
With Mitigation	Medium term	Localised	Moderate	Unlikely	**LOW**

Impact 2: Impacts due to changes in hydrology

The project will result in the diversion of up to a maximum of about 38 m^3/s of water after the Environmental Flow Reserve has been met and when sufficient river flow is available. The diverted water will be piped approximately 4.6km at a depth of up to 10m, and then empty into a head pond retained by a low levee (max. height 3m). The headpond will be approximately 90m wide and 130m long, generally between 1 and 3 metres deep, and have a surface area of about 12,000 m^2. After power generation in the Power House, the tailrace tunnel would travel 675m through rock and exit into the lower 'palaeochannel' approximately 200m below the 'palaeo falls', before draining back into the Orange River.

Cause and comment

These changes will obviously generate changes in the distribution and availability of water for the fauna in the project area.

- At low water levels the weir will retain water in a greater area of the upstream braided channels. In general this will be a positive or insignificant impact.
- The southern route of the proposed water conduit runs in, or in very close proximity to the right edge of the upper 'palaeochannel', which forms a significant ecological corridor of High Sensitivity. Intrusion into this area should be avoided.
- The headpond will form a substantial new water body that would provide increased access to water for large mammals, birds and amphibians. This will have a generally positive impact on the fauna, although increased mortality from small animals passing into the power tunnel can also be expected and should be mitigated.
- The discharge of up to 38 cumecs of water into the lower 'palaeochannel' from the tailrace for up to 8-9 months of the year will result in a substantial increase of water into the seasonally dry drainage line. This will generate increased vegetation growth resulting in increased riparian habitat for all vertebrate groups. The numbers of fish migrating up from the Orange River will also increase and form increased food for piscivores, including various birds (fish eagle, cormorants, kingfishers, etc), otters, water monitors, etc. This change in hydrology will also have a generally positive impact on the fauna.
- Deaths and breeding disruptions may occur with the sudden outflow of water into the lower 'palaeochannel' when power generation is initiated. This should be avoided.

Mitigation and management

The changes in hydrology will be generally positive, although increased mortality will temporarily occur from the sudden inflow of water into the lower 'palaeochannel'.

- Trash racks should be erected at the entrance of water into the power house from the headpond to prevent large mammals or reptiles (monitors and large tortoises) from being sucked into the generating tunnel.
- The release of water into the lower 'palaeo channel' after power generation should occur in stages before full discharge to allow wildlife to vacate the area.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Positive	Definite	**HIGH+**
With Mitigation	NA	NA	NA	NA	**NA**

Issue 3: Additional operational impacts on fauna

Few impacts are likely to result in the operational phase of the project. Operation of power generation is automated and controlled off-site. The design of the weir means that at low water levels, water flow to the power plant ceases. Many operational impacts result from increased transport in the region. However, low levels of access are required for maintenance and repair of the facility. Roads are known to alter physical characteristics of the environment, namely: soil density, temperature, soil water content, light penetration, dust production, surface water flow, run-off pattern and sedimentation. Via their impacts on these parameters roads affect ecosystems, biological communities and species in numerous and different ways. The significance of these effects is determined largely by the location, density, and distribution of roads across the landscape. Generally, roads have negative effects on the biotic integrity in both terrestrial and aquatic ecosystems and these effects can be classified under various categories: increased mortality from road construction and vehicle collisions; modification of animal behaviour, particularly movement patterns; alteration of the physical environment; and chemical environment; spread of exotic species; and increased alteration and use of habitats by humans.

Impact 1: Increased Dust Levels

Cause and comment

Increased dust levels are common after veld clearance activities, and from vehicular traffic, even on paved surfaces. Dust settling on adjacent vegetation can block plant photosynthesis, respiration and transpiration, in addition to causing physical injuries to plants. Its presence may also make plants unpalatable, thus acting as a possible deterrent to grazing. Dust from road surfaces can also transport chemical pollutants to adjacent regions, thus affecting riparian ecosystems via impacts on water quality.

Mitigation and management

- After the construction phase, roads within the area should be returned to small tracks.
- Road speed throughout the project area should be limited to <50km per hour to curtail dust generation.
- Road use during and immediately after heavy rain should be prohibited to avoid damage to the surface.
- All vehicular traffic should be restricted to existing tracks, and no off-road vehicle activity should be permitted.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Slight	Definite	**LOW**
With Mitigation	Medium term	Localised	Slight	Probable	**LOW**

Impact 2: Noise Pollution

Cause and comment

Operational activity will be restricted to inspection and maintenance with limited vehicle traffic. This will have an intermittent impact that may reduce the abundance of sensitive birds and large mammals.

Mitigation and management

- Mitigation of this impact involves minimisation of night driving in the project area.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Localised	Slight	Definite	**LOW**
With Mitigation	Medium term	Localised	Slight	Probable	**LOW**

7.4.5 Heritage

Impacts on heritage are only significant during the construction phase of a project, when sensitive heritage features may be altered or destroyed.

7.4.6 Noise

Due to the project being located underground, no impacts will result in the operations phase.

7.4.7 Socio-economic and Tourism

Issue 1: Local Economic Development

The possibility for the project to support Local Economic Development (LED) is not limited to the construction phase. The following impacts relate to LED under the project's operational phase:

- Impact 1.1: Financial Benefits to the Riemvasmaak Community Trust;
- Impact 1.2: Establishing a Broad-Based Community Trust;
- Impact 1.3: Stimulating Small, Medium and Micro Enterprises;
- Impact 1.4: Increase in Informal Traders;
- Impact 1.5: Increase Tourism Opportunities;
- Impact 1.6: Employment Opportunities.

Impact 1.1: Financial Benefits to the Riemvasmaak Community Trust

Cause and Comment

The RCT will receive income *via* two sources, namely rental income for the use of their land, as well as being a shareholder in the company and, thus, receiving dividends from the project. It is understood that the payment of dividends will commence six months after the project becomes operational. Both of these will provide a consistent income for the RCT throughout the projects lifespan. While it could not be confirmed for what exactly this income will be used, it was confirmed by the RCT trustees that it will be put towards the upliftment of the community. In addition to this income -the broader community (50km radius) will also derive income of between 2.5 and 5% shareholding (funded by the IDC) as well as from the committed 1.5 to 2 % (of turnover) SED spend by the Project Company

Enhancement Measures

The following enhancement measures are proposed:

I. Ensure that there are no irregularities with the spending of monies received by the RCT;
II. Ensure that all monies received by the RCT are used for community upliftment purposes;
III. Ensure that the agreed conditions are adhered to;
IV. Ensure that any monies paid to the RCT are used for community upliftment.

Significance Statement

With enhancement measures, the impact will have a high positive impact. The reason for this is the fact that the impact is long-term, regional, and the likelihood is definite. Without mitigation measures, the impact will have a high positive impact. The reason for this is that the impact is long-term, regional, and the likelihood is definite.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Enhancement	Long-Term	Regional	Beneficial	Definite	**HIGH +**
With Enhancement	Long-Term	Regional	Beneficial	Definite	**HIGH +**

Impact 1.2: Establishing a Broad-Based Community Trust

Cause and Comment

In terms of the REIPPP programme, all communities within 50km of the project are required to benefit from the project. While details are not finalised as to how the Broad Based Community Trust would be structured in terms of the REIPPP programme, the needs of the surrounding communities are to be identified and strategies put in place as to how these will be addressed. It is assumed that the Broad Based Community Trust would essentially be tasked with addressing the socio-economic needs of communities within 50km of the project site.

Enhancement Measures

The following enhancement measures are proposed:

I. The project proponent should have representatives on the trust committee;
II. Ensure that there are no irregularities with the spending of monies received;
III. Ensure that all monies received are used for community upliftment purposes.

Significance Statement

With enhancement measures, the impact will have a high positive impact, as it is long-term and regional. Without mitigation measures, the impact will have a high positive impact, as it is long-term and regional.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Enhancement	Long-Term	Regional	Beneficial	May Occur	**HIGH +**
With Enhancement	Long-Term	Regional	Beneficial	May Occur	**HIGH +**

Impact 1.3: Stimulating Small, Medium and Micro Enterprises

Cause and Comment

This impact has already been discussed. However, it is anticipated that the significance of this impact would be slightly different during the operational phase.

With Enhancement

With enhancement, the project will have a moderate positive impact on the stimulation of SMMEs.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Enhancement	Long-Term	Regional	Slight	Probable	**MOD +**
With Enhancement	Long-Term	Regional	Moderate beneficial	Probable	**MOD +**

Impact 1.4: Increase in informal traders

Cause and Comment

This impact has already been discussed. There will be no difference between the impact's significance during the construction or operational phases.

Impact 1.5: Increased Tourism Activities

Cause and Comment

It was noted by representatives of the Riemvasmaak Tourism Association and representatives of the AFNP that there are plans to extend tourism into the northern sections of the AFNP. Moreover, it was noted that there is potential for the proposed hydropower scheme to be used to generate tourism. In the event of the scheme being used as a tourism attraction, various spin-off opportunities arise, such as employment opportunities for tour guides which will assist the local communities.

Enhancement Measures

The following enhancement measures are proposed:

I. The project should consider the potential to stimulate the tourism sector early on in its design, such as to construct viewing decks, or consider the project's marketability as a tourism attraction;
II. Ensure that tours of the hydroelectric scheme are well marketed;
III. Ensure that guides are well trained and can provide tourists with the necessary information.

Significance Statement

With enhancement, the project will have a low positive impact on the stimulation of tourism, as the impact severity would be slight and the risk thereof probable. With few or no enhancement measures, the project should still have a low positive impact on the stimulation of tourism, as the impact severity would be slight and the likelihood is probable.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Enhancement	Long-Term	Local	Slight	Probable	**LOW +**
With Enhancement	Long-Term	Local	Slight	Probable	**LOW +**

Impact 1.6: Employment Opportunities

Cause and Comment

During the operational phase, between five and ten permanent jobs will ultimately be created once the necessary skills training has taken place. Of the aforementioned, only one job would not be local. In addition, there is the likelihood of skills development as an indirect result of the employment opportunities. This will increase the ability of individuals to access other skilled positions of a similar nature.

Enhancement Measures

Such measures have already been discussed.

Significance Statement

With enhancement, the project will have a high positive impact on employment generation, as the likelihood of this impact is definite and the impact is long-term. With few or no enhancement measures, the project will have a moderate positive impact on employment generation. The reason for this is the fact that the impact would be reduced from being beneficial, to only moderate beneficial.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Enhancement	Long-Term	Regional	Moderate beneficial	Definite	**MED +**
With Enhancement	Long-Term	Regional	Beneficial	Definite	**HIGH +**

Issue 2: Health and Safety

Under this issue, the possibility of increased road accidents, related to an increase in vehicle traffic, is discussed.

Impact 2.1: Increased Road Accidents

Cause and Comment

This impact has been discussed under the construction phase. However, the impact should be less severe during the operational phase.

Mitigation Measures

With mitigation, the project will have a low negative impact in terms of increased road accidents. The reason for this is the fact that the impact would be slight. With few or no mitigation measures, the project will have a low negative impact in terms of increased road accidents.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Mitigation	Long-Term	Regional	Slight	Definite	**LOW -**
With Mitigation	Long-Term	Regional	Slight	Definite	**LOW -**

Issue 3: Social Services

Under this issue, improved energy production is considered.

Impact 3.1: Improved Energy Production

Cause and Comment

Through the proposed project, there will be additional base load supplied to Eskom who, at present, are experiencing shortfalls in power. The benefits of the project will include carbon savings from the decreased reliance on non-renewable sources such as coal-fired power stations, as well as contributing towards South Africa's energy requirements.

Enhancement Measures

I. Ensure that the project infrastructure is well maintained to ensure the efficient functioning of the project throughout its life span.

Significance Statement

With appropriate enhancement, the project will have a moderate positive impact in terms of improved energy production in South Africa. With few or no enhancement measures, the project will still have a moderate positive impact in terms of improved energy production in South Africa.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Operational Phase					
Without Mitigation	Long-Term	Regional	Moderate	Probable	**MED +**
With Mitigation	Long-Term	Regional	Moderate	Probable	**MED +**

Issue 4: Cultural Heritage

Cultural heritage impacts have been discussed under the construction phase. However, it is also anticipated for the project to have impacts on cultural heritage during its operational phase. These impacts largely relate to affected people's sense of place.

Impact 4.1: Sense of Place

Cause and Comment

This impact has been discussed under the construction impacts. However it remains a general impact during the project's operational phase. The significance of the impact would remain unchanged, although the spatial scale would become long-term, as opposed to short-term.

7.4.8 Visual

Impact: The potential negative visual impact of the project component on sensitive visual receptors in close proximity to the underground infrastructure.

Cause and comment

Sense of place refers to a unique experience of an environment by a user, based on his or her cognitive experience of the place. Visual criteria and specifically the visual character of an area (informed by a combination of aspects such as topography, level of development, vegetation, noteworthy features, cultural / historical features, etc.) play a significant role. A visual impact on the sense of place is one that alters the visual landscape to such an extent that the user experiences the environment differently, and more specifically, in a less appealing or less positive light.

Tourism access and development within the Augrabies Falls National Park is limited to the area south of the river. This corresponds with the zoning of the Park, which has allocated both low and high intensity leisure activity zones in this area. The northern part of the Park is zoned as Remote and Primitive in the internal AFNP Management Plan. Should this project proceed, however, the zoning of the Park may need to change. In this respect, the area to the north of the river may be considered for tourism development in the future. The presence of the power station infrastructure should not be a limiting factor if all the project infrastructure is located underground. The weir, offtake structure, headpond embankment and intake structure will not be underground, but will not be visible from the falls viewing platforms or the rest camp.

The land earmarked for the proposed hydropower stations however has a very low threshold for development (i.e. it can spoil the character very easily) and caution should be taken against the inappropriate proliferation of similar development proposals.

As the project infrastructure is located below ground, the expected overall visual impact of the project is of moderate significance, but can be reduced to low by implementing recommended mitigation measures.

Mitigation and management

- During operation, the maintenance of the structures (e.g. the substation), the access roads, the power line and other ancillary structures and infrastructure will ensure that the facility does not degrade, thus aggravating visual impact.
- Roads must be maintained to forego erosion and to suppress dust, and rehabilitated areas must be monitored for rehabilitation failure. Remedial actions must be implemented as and when required.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Moderate	Probable	**MODERATE**
With Mitigation	Long term	Study area	Moderate	Probable	**LOW**

7.4.9 Seismicity

Cause and comment

The level of seismic activity recorded during the currency of the ongoing swarm has been relatively low, with 16 events with magnitude of between 4.0 and 5.0 (Richter scale) and relatively low levels

of horizontal acceleration being recorded up to December 2014. Nevertheless, repeated seismic events during the operational life of the facility may result in damage to structures, unless they have been designed to resist the effects of such events.

Mitigation and management

Structures must be designed to resist seismic events of the magnitude and intensity expected in the general area, and recorded during recent events, including

- Reinforcement design should follow good practice for earthquake resistance as detailed in SANS 10160-4:2011 (Basis of Structural Design and Actions for Buildings and Industrial Structures — Part 4: Seismic Actions and General Requirements for Building).
- Culverts must be designed with flexible joints between sections.
- Culverts must be bedded on and backfilled with granular material.
- The design of the power chamber must take account of the integrity of the parent rock, and include measures such as concrete spraying and rock bolting as appropriate to ensure structural integrity.

Significance statement

The spatial scale is long term, and overall significance is Moderate without mitigation. Design that accounts for the effects of seismic events reduces the overall significance to Low by reducing the severity to Slight and the Probability to Unlikely.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Moderate	Probable	**MODERATE**
With Mitigation	Long term	Localised	Slight	Unlikely	**LOW**

7.4.10 Economic

Impact 6: Increased Tourism Bed-Nights

Cause and Comment

Small number of bed-nights will be required by skilled and professional persons visiting / servicing the project.

Mitigation and Management

Not applicable – no appropriate enhancement measures.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Slight Beneficial	Probable	**LOW +**
With Mitigation					**N / A**

Impact 7: Increased Employment

Cause and Comment

Small number of permanent jobs (5-10) will be created on the facility.

Mitigation and Management

Maximise the number of local people who can be employed operationally by training and up skilling.

Significance of Impact

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study area	Slight Beneficial	Probable	**LOW +**
With Mitigation	Medium term	Study area	Slight Beneficial	Definite	**MODERATE +**

Impact 8: Benefits for RCT, Broad-based Community Trust and Socio-economic Expenditure

Cause and Comment

Income from rental and dividends and expenditure on social development projects.

Mitigation and Management

Not applicable – no appropriate enhancement measures.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study area	Moderate Beneficial	Definite	**MODERATE +**
With Mitigation					**N / A**

Impact 9 Impacts on Energy

Cause and Comment

Clean energy produced for the national grid.

Mitigation and Management

Not applicable – no enhancement measures.

Significance of Impact

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Permanent	National	Slight Beneficial	Definite	**MODERATE +**
With Mitigation					**N / A**

7.5 Decommissioning Phase Impacts

7.5.1 Agriculture

The agricultural impacts and mitigation measures applicable to the decommissioning phase are not different from those of the construction phase.

7.5.2 Aquatic Ecology

The aquatic impacts and mitigation measures applicable to the decommissioning phase are not different from those of the construction phase.

7.5.3 Vegetation and botanical

Impacts during decommissioning will not be different from those identified for the construction phase. The site will need to be rehabilitated after decommissioning.

7.5.4 Fauna

Issue 1: General decommissioning phase impacts on fauna

A variety of impacts are likely to result from the decommissioning of the various components of the project. General decommissioning operations (e.g. transport, fuel dumps, etc.) may cause chemical pollution, raise dust levels, increase noise and light levels and lead to changes in water hydrodynamics and fire regimes. The extent of these impacts results, in part from what future land use options are envisaged after the termination of the project. Return to a pristine state will require the removal of the weir, head pond, power house and generating equipment. Access roads used in construction and access during the operational phase will be difficult to remove, particularly the access route down the steep canyon walls of the lower ‘paelaeochannel’.

Impact 1: Increased Dust Levels

Cause and comment

Increased dust levels are common during decommissioning, especially in association with destruction of infrastructure and the removal from site of equipment, machinery and construction materials such as metal and concrete. Dust from rubble and road traffic can be expected.

Mitigation and management

- Road speeds throughout the site, especially during extreme dry climatic conditions, should be limited to curtail dust generation.
- Speed limits on unpaved roads should be reduced, and in areas of high dust production road surfaces should be dampened.
- Any chemicals that need to be transported should be done in closed trucks or containers to avoid contamination to the surrounding area.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Short term	Study Area	Slight	Definite	**LOW**
With Mitigation	Short term	Localised	Slight	Probable	**LOW**

Impact 2: Noise Pollution

Cause and comment

Decommissioning activities, especially increased road traffic and the operation of heavy machinery will generate increased noise levels in the project area. This will reduce the abundance of sensitive birds and large mammals.

Mitigation and management

- Mitigation of this impact is difficult, but should involve prohibition of decommissioning activities before 06h00 and after 18h00.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Medium term	Study Area	Moderate	Definite	**MOD**
With Mitigation	Short term	Localised	Moderate	Definite	**LOW**

7.5.5 Heritage

Impacts on heritage are only significant during the construction phase of a project, when sensitive heritage features may be altered or destroyed.

7.5.6 Noise

The noise impacts and mitigation measures applicable to the decommissioning phase are not different from those of the construction phase.

7.5.7 Socio-economic and Tourism

Issue 1: Local Economic Development

The impacts related to LED have been discussed. In the unlikely event of the hydropower station being decommissioned, it is anticipated that the project will continue to stimulate LED in several ways. These are in terms of employment opportunities, informal traders, the stimulation of SMMEs, tourism, financial benefits to the RCT, and continued financial benefits through the establishment of a community trust. These themes are discussed as impacts under this issue.

Impact 1.1: Increased Employment Opportunities

Cause and Comment

Although the number of jobs to be created during the decommissioning phase is unknown, it is assumed that some extra opportunities might be created to disassemble the plant and rehabilitate the area.

Enhancement Measures

Enhancement measures have already been described in construction and operational phases.

Significance Statement

With appropriate enhancement, the decommissioning phase of the project should have a high positive impact in terms of providing employment opportunities. With few or no enhancement measures, the project should have a moderate positive impact in terms of providing employment opportunities.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Decommissioning Phase					
Without Mitigation	Short-Term	Regional	Moderate beneficial	Definite	**MED +**
With Mitigation	Short-Term	Regional	Beneficial	Definite	**HIGH +**

Impact 1.2: Increase in Informal Traders

Cause and Comment

Although the number of jobs to be created during the decommissioning phase is unknown, it is assumed that some extra opportunities might be created to disassemble the plant and rehabilitate the area. The significance of this impact remains unchanged from the same impact discussed under the construction phase.

Impact 1.3: Stimulating Small, Medium and Micro Enterprises (SMMEs)

Cause and Comment

This impact has been discussed. The impact is also relevant to the decommissioning phase, as services would be required for disassembling infrastructure, recycling and rehabilitation.

Enhancement Measures

Enhancement measures have already been described for the construction phase.

Significance Statement

With appropriate enhancement, the decommissioning phase of the project should have a low positive impact in terms of stimulating the development of SMMEs. With few or no enhancement measures, the project should have a moderate positive impact in terms of providing employment opportunities.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Decommissioning Phase					
Without Mitigation	Short-Term	Regional	Slight beneficial	Probable	**LOW +**
With Mitigation	Short-Term	Regional	Moderate beneficial	Probable	**MEDIUM +**

Impact 1.4: Tourism

Cause and Comment

As the Augrabies Falls is a significant tourism destination within the Northern Cape, it is believed that the decommissioning phase of the project could affect tourism activities negatively, but decommissioning is unlikely to happen for the next 60 to 80 years. Impacts in terms of noise, aesthetics or dust could all affect the tourism industry during the decommissioning phase. The overall significance of this impact remains unchanged from the same impact already discussed for the construction phase.

Impact 1.5: Financial Benefits to the Riemvasmaak Community Trust

Cause and Comment

The RCT will continue to receive rental income from the project during the decommissioning phase. The same impact has been discussed under the Operational Phase, with no changes in the overall significance.

Impact 1.6: Establishing a Broad-Based Community Trust

Cause and Comment

This impact was discussed under the operational phase. It is believed that the project should continue to benefit the surrounding communities during the decommissioning phase through such a trust. The overall significance of this impact would remain unchanged.

Issue 2: Health and Safety

Several health and safety impacts should be considered during the project's decommissioning phase. The main reason for this is the possibility of employing more workers during this time, as well as hiring SMMEs for particular decommissioning tasks. The impacts discussed under this issue relate to the spread in diseases, road accidents, dust, increased fire hazard, and the possibility of an increase in criminal activity.

Impact 2.1: Spread in Diseases

Cause and Comment

This impact will remain unchanged from the same impact discussed during the construction phase.

Impact 2.2: Road Accidents

Cause and Comment

This impact will remain unchanged from the same impact discussed during the construction phase.

Impact 2.3: Dust

Cause and Comment

Dust will be generated during the decommissioning phase. This impact will remain unchanged from the same impact discussed during the construction phase.

Impact 2.4: Increased Fire Hazard

Cause and Comment

This impact will remain unchanged from the same impact discussed during the construction phase.

Impact 2.5: Increased Criminal Activities

Cause and Comment

This impact will remain unchanged from the same impact discussed during the construction phase.

Issue 3: Social Infrastructure

It is believed that more workers might be needed during the project decommissioning phase. This might result in an increased pressure on the existing infrastructure, as more labour will need to be accommodated.

Impact 3.1: Increased Pressure on Existing Infrastructure

Cause and Comment

This impact remains unchanged from the same impact discussed during the construction phase.

Issue 4: Cultural Heritage

The decommissioning phase will also have an impact in terms of the area's cultural heritage. The impact discussed under this issue related to this phase's aesthetic impact on the area.

Impact 4.1: Aesthetic Impact

This impact remains unchanged from the same impact discussed during the construction phase.

7.5.8 Visual

Impact: The potential residual visual impact of the project component after the decommissioning of the power station.

Cause and comment

Decommissioning of the project, breakdown and removal of all project infrastructure, and rehabilitation of the site at the end of its useful life.

Mitigation and management

- Once the power station has exhausted its life span, the main facility and all associated infrastructure not required for the post rehabilitation use of the site should be removed and all disturbed areas appropriately rehabilitated. An ecologist should be consulted to give input into rehabilitation specifications.
- This recommendation relates to the substation and overhead power lines and tracks. Underground infrastructure (e.g. subterranean power lines) should be left in place rather than digging this up and creating an additional impact.
- All rehabilitated areas should be monitored for at least four years following decommissioning, and remedial actions implemented as and when required.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Study area	Low	Probable	**MODERATE**
With Mitigation	Long term	Study area	Low	Probable	**LOW**

7.6 Cumulative Impacts

Legal requirements in respect of Cumulative impacts

"***cumulative impact***", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities;

GN R.543, s31 - Environmental impact assessment reports

(2) An environmental impact assessment report must contain all information that is necessary for the competent authority to consider the application and to reach a decision contemplated in regulation **35**, and must include –

(l) an assessment of each identified potentially significant impact, including—
- (i) cumulative impacts;
- (ii) the nature of the impact;
- (iii) the extent and duration of the impact;
- (iv) the probability of the impact occurring;
- (v) the degree to which the impact can be reversed;
- (vi) the degree to which the impact may cause irreplaceable loss of resources; and
- (vii) the degree to which the impact can be mitigated

The definition of cumulative impacts in the NEMA EIA Regulations refers to "*similar or diverse* (that is, different) *activities or undertakings in the area*". A more comprehensive definition is found in the recently-revised (December 2014) EIA Regulations, as follows:

> *"**cumulative impact**", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities;*

The new definition is similar in most respects to the definition of cumulative impacts in the International Finance Corporation's Performance Standard 1 - Assessment and Management of Environmental and Social Risks and Impacts:

> *"**Cumulative impacts** [are impacts] that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted."*

PS1 goes on to say that:

> *"Cumulative impacts are limited to those impacts generally recognised as important on the basis of scientific concerns and/or concerns from Affected Communities. Examples of cumulative impacts include: incremental contribution of gaseous emissions to an airshed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or more traffic congestion and accidents due to increases in vehicular traffic on community roadways."*

Cumulative impacts were assessed in the specialist studies as follows:

7.6.1 Agriculture

The agricultural assessment found that the project site is on land of extremely limited agricultural potential, which is not currently used for agriculture, and is not likely to be used for agriculture in the future. The impact of the main infrastructural elements of the project on agricultural activities on the project site was therefore assessed as being low. The impacts of the overhead transmission line from the proposed new substation on the north bank of the Orange River to the point of connection to the Eskom grid crosses vineyards, but the impact was also assessed as low provided that the route of the line is carefully selected in consultation with the landowners / farmers.

The cumulative impacts of the project on other agricultural activities in the project's area of influence was assessed as negligible, and the cumulative impacts of other agricultural activities in the project's area of influence on agriculture on the project site was also assessed as negligible.

7.6.2 Aquatic Ecology

Existing impacts on the river

As discussed in section 7.1.2 the Orange River is a highly altered system. There are two very large dams (Gariep and Vanderkloof, with a combined storage capacity of about 8 500 million cubic metres), and the much smaller Boegoeberg Dam (capacity about 20 million cubic metres, greatly reduced by sediment trapped in the dam basin), and these have facilitated abstraction for irrigated agriculture and mining. These uses, together with transfers from the Senqu in Lesotho into Gauteng via the Lesotho Highland Water Project, are consumptive, and have reduced the runoff in the river to about half of its undeveloped annual discharge. Abstractions of water for irrigated agriculture and the generation of electricity at the two larger dams – both are peaking power stations - have considerably altered the seasonality of flow in the river.

There is one other existing hydroelectric facility in the river, a 10MW installed capacity station at the Neusberg Weir, which came into operation in March 2015. The Kakamas HPP makes use of the head generated by the weir, which is about 44km upstream from the proposed facility along the river. It is a run-of-river project, and reduces the natural flow in the river along an approximately 2.6km-long reach of the river. All water diverted into the power station is returned to the river, with negligible losses. The station can generate base load for as long as water is available in the river for diversion into the facility. The project has no impact on, and will not be impacted by, the proposed Riemvasmaak HPP.

Possible future impacts

Three hydropower projects are proposed upstream of Augrabies:

(i) The Boegoeberg HPP, a 10MW run-of-river station near Groblershoop, will use the head generated by the 12m-high Boegoeberg Dam. The station will be able to generate base load for as long as water is available in the river for diversion into the facility Environmental Authorisation has been granted for this project. The project will have no impact on, and will not be impacted by, the proposed Riemvasmaak HPP. The project will, however, be impacted by the two projects discussed below.

(ii) Rooikat HPP near Hopetown. This 22MW project will require the construction of a dam wall between 30 and 45m high, which will impound 36.4 million cubic metres of water in a reservoir with a surface area of around 550 hectares. This project will be a run-of-river project, but the necessity for a high dam to create the driving head will almost certainly result in a further alteration of the flow regime of the river. This project will have an impact on the, the proposed Riemvasmaak HPP, which could be positive or negative depending on the way the flow regime is altered. The project received Environmental Authorisation from DEA in June 2015. The RVM project will have no impact on this proposed project.

(iii) The Meerkat HPP, near Douglas. This 20MW capacity facility will require the construction of a weir of unspecified height to generate the head to drive the turbines. It is assumed that the

station will be run-of-river, and comments on the impacts are as for the Rooikat HPP above.

There is a 30MW run-of-river HPP proposed downstream of Augrabies, using the head generated by the Orange Falls / Ritchie Falls, near Onseepkans, where the Orange River forms the boundary between South Africa and Namibia. The project will not impact or be impacted by the Riemvasmaak HPP.

In 2010 the Namibian power utility NamPower announced plans to develop 100 MW run-of-river Lower Orange Hydroelectric Power Scheme (LOHEPS), which would entail the construction of up to nine small hydroelectric power stations, ranging from 6 MW to 12 MW, along the Lower Orange River.

Impacts on the Orange River mouth

The small run-of-river hydroelectric power stations that already exist or are proposed make use of existing vertical falls in the course of the river (dams ,weirs and waterfalls), and therefore require little or no storage capacity. Accordingly unlike facilities that require large impoundments to provide the driving head (Gariep and Vanderkloof dams, for instance), they do not alter the seasonality of flow in the river. Also, since all of the water diverted through the turbines is returned to the river downstream of the abstraction point, they have no impact on the quantitative flow regime of the river.

These projects, including the proposed Riemvasmaak HPP, will have no impact on the flow regime of the river where it flows into the Atlantic Ocean. There will therefore be no impacts whatsoever on the Ramsar wetland at the Orange River Mouth.

7.6.3 Vegetation

There are approximately 30 renewable energy projects - operational, under construction or planned - in the Northern Cape, including about 25 concentrated solar and solar photovoltaic projects, which have the biggest spatial footprint and therefore the greatest impact on the land surface and whatever vegetation occurs on the site. The project closest to the proposed hydropower project is the Augrabies Photovoltaic Power Project, which is about 9km south-west of the HPP. This project will impact Bushmanland Arid Grassland on the farm Rooipad 15 Portion 9, but this vegetation type is extremely extensive and relatively uniform in its distribution. Cumulative loss of this vegetation type due to renewable energy infrastructure is therefore currently extremely small and is not expected to increase significantly in the mid- to long term.

The construction of the intake weir will impact Lower Gariep Alluvial Vegetation to a small localized extent, and will not make a significant contribution to the cumulative loss of this Endangered vegetation type.

No indirect impacts of the proposed HPP were identified on the vegetation of the study area or the immediate vicinity.

Although there is a large area of Lower Gariep Broken Veld on Riemvasmaak no cumulative impacts were identified for this vegetation type.

7.6.4 Fauna

Issue 1: Loss of faunal biodiversity

Historically, the Nama Karoo supported a large diversity of animals as noted by early travellers and as recorded in present day place names (Skead, 1980). Many small (e.g. steenbok, duiker) and large ungulates (e.g. gemsbok, eland) as well as mega-herbivores (such as elephant, black rhinoceros and hippopotamus) and their associated predators (e.g. lion, cheetah, hyena) were recorded in the region and reflect this diversity (Skead, 1980). However, the density of animals, as well as the extent of population fluctuations that would have occurred in the Nama Karoo prior to

colonial settlement at the Cape, is harder to determine (Hoffman & Rhode 2006).

It appears that wildlife was only seasonally abundant in the region prior to colonialism, and although the 'linear oasis' of the Orange River would have supplied water for many species it would not have supported large herds of grazing ungulates. Encroaching farmers would have regarded wildlife as both food and vermin that competed with their livestock for food, space and water (Lovegrove 1993). Along with habitat loss to fenced livestock farms and a rinderpest outbreak at the end of the 19th Century, game numbers were dramatically reduced. Fence lines also restrict seasonal game movements, restricting their migration to resources. Fortunately, fences do not limit birds or reptiles. Many granivorous birds migrate hundreds of kilometres to find food in the region after good rainfall events stimulate plant growth (Dean and Milton 1999).

Existing land use is primarily focused on agriculture, with livestock grazing restricted to regions out of the Orange River irrigation zone. Irrigation-dependent cultivation, of grapes and citrus primarily, is now widespread along the Lower Orange River, particularly in the zone from Keimos to Augrabies.

Impact 1: Surrounding land use impacts on fauna

Cause and comment

While many of the larger mammals were eliminated in historical times, present day impacts on fauna come in numerous forms. Predatory animals such as black-backed jackal (*Canis mesomelas*), caracal (*Felis caracal*) and leopard (*Panthera pardus*) have been known to effect stock numbers, thus impacting upon local livelihoods in the region. However, the hunting and trapping of predators can often lead to an increase in predator numbers because of the elimination of alpha males that restrict access of other predators within their territory (NDBSP 2008). Thus, common methods of predator control can have the opposite effect to that which is intended.

Fence lines along roads and between farm paddocks may restrict the movement of non-volant (non-flying) large animals across the landscape. The faunal impact depends on the size and structure of these linear barriers. Low electric fences, designed to restrict the moment of small predators, e.g. jackal, are particularly lethal to other wildlife, e.g. larger tortoises (Burger & Branch 1994). The use of poisoned carcasses by livestock farmers to kill "problem" animals such as black-backed jackal and hyena often results in poisoning of non-target raptors and other scavenging species (Lloyd 1999, Anderson 2000). Some species, like the Martial Eagle (*Polemaetus bellicosus*) and Black Eagle (*Aquila verreauxii*), perceived to prey on domestic livestock and poultry, may be deliberately targeted (Anderson 2000). Practices such as the use of gin traps are also problematic for local biodiversity, as it is an indiscriminate method that usually serves to eradicate more non-target animals, such as tortoises, aardvarks, etc., than it does the predator in question.

Drownings in farm reservoirs also account for a significant number of raptor mortalities in the Karoo (Anderson 2000), whilst pesticides used to control brown locust (*Locustana pardalina*) outbreaks also impact wildlife severely, with high concentrations being found at the top of the food chain, particularly lizards (Alexander et al. 2002) and raptors (Lovegrove 1993).

One of the most important faunal impacts results from competing requirements for water use in the region. Heath & Brown (2007) note that the construction of dams for electric power generation has resulted in the loss of species diversity which may be regionally severe, and the river immediately below Vanderkloof Dam has been described as an ecological desert. They summarize that the environmental issues associated with the Orange River are "directly related to the anthropogenic use of the water. The major impact is due to the altered flows of the Orange River due to man reallocating this water for uses outside the catchment, for hydro-power, agricultural and mining use. As a result the river's ecological integrity has been compromised to such an extent that the current flow regime has resulted in the loss of biodiversity, nutrient enrichment, increasing salt loads and nuisance plants and animals. However, these concerns relate mainly to large schemes

within the river itself, and not smaller run of river schemes.

In a related consequence, Myburgh & Nevill (2003) noted that in 1996 blackflies (particularly *Simulium chutteri*) caused R88 million damages per annum in the middle and lower Orange River. They state that "invertebrates in the lower Orange River are largely modified due to the overwhelming and persistent abundance of filter-feeders, in particular the pest proportion numbers of the blackfly, *Simulium chutteri*. The large-scale programme to control this pest, using aerial applications of insecticides, highlights the extent of the problem (Palmer, 1993). The outbreaks are attributed to stable flow conditions, in particular high winter flows, deterioration in water quality and encroachment of instream vegetation."

Existing land use impacts on fauna in the project area results in a definite severe negative impact in the long-term in the region. The environmental significance of this impact is High.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long-term	Regional	Severe	Definite	**HIGH**
With Mitigation	NA	NA	NA	NA	**NA**

Issue 2: Habitat Impacts

The Lower Orange River is now extensively utilised for irrigated cultivation. This has resulted in the removal of natural vegetation for cultivation, particularly Lower Gariep Alluvial Vegetation. Simmon & Allen (2002) note that riverine habitats shelter the greatest bird diversity within the Orange River avifauna.

Impact 1: Habitat Loss

Cause and comment

Large sections of the Lower Orange River above the Augrabies Falls are now heavily degraded by conversion to irrigated cultivation. This impact is continuing, with irrigated cultivation occurring further away from the river. Existing and potential land-use practices that currently, and may further threaten the region's biodiversity include:

- The increase of communally-owned land, if accompanied by increasing small scale livestock use, may lead via overgrazing to desertification.
- Increasing irrigated agriculture, especially citrus suitable for soils outside the flood plain of the Orange River, will result in further habitat loss.
- The increasing use of fertilizer and insecticide run-off from irrigated lands may secondarily affect riverine vegetation, resulting in further habitat loss, downstream from the agricultural areas.

Existing habitat loss on the fauna has resulted in the project area in a definite severe negative impact in the long-term in the region. The environmental significance of this impact is High.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long-term	Regional	Severe	Definite	**HIGH**
With Mitigation	NA	NA	NA	NA	**NA**

7.6.5 Heritage

Impact: Potential impacts on archaeological heritage resources

Cause and Comment, Mitigation

Many similar pre-colonial sites will have been lost through commercial farming along the banks of the Orange River. No mitigation measures are feasible.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Moderate	Definite	**Moderate**
With Mitigation	NA	NA	NA	NA	NA

Impact: Potential impacts on graves

Cause and Comment, Mitigation

Many graves have no doubt already been impacted by commercial farming activities and new lands continue to be ripped in the area. Early researchers also did much damage to graves through excavation of a very large number of them. No mitigation measures are feasible.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Severe	Probable	**High**
With Mitigation	NA	NA	NA	NA	NA

Impact: Potential impact on the cultural landscape

Cause and Comment, Mitigation

This cultural landscape is restricted to the greater Riemvasmaak area and it is likely that no/very few other similar features have been disturbed in recent decades. No mitigation measures are feasible.

Significance Statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Localised	Moderate	Definite	**Moderate**
With Mitigation	NA	NA	NA	NA	NA

7.6.6 Noise

The area is very quiet and remote, therefore no noise-related cumulative impacts are anticipated.

7.6.7 Socio-economic and Tourism

Issue 1: Local Economic Development

The project should continue to provide support in terms of LED, although one negative aspect of the project could entail a negative effect on the cumulative tourist activities in the region. The following impacts are discussed under this issue:

- Impact 1.1: An increase in expendable income;
- Impact 1.2: Improved access to social services; and
- Impact 1.3: Increased tourism activities.

Impact 1.1: An Increase in Expendable Income

Cause and Comment

An increase in expendable income within the local communities is expected to be a cumulative impact for many reasons. This includes an increase in employment opportunities, supporting the RCDT and the growth in informal traders, as well as establishing a Broad-Based Community Trust. In addition, establishing and supporting the development of SMMEs should also lead to more expendable income within the surrounding communities.

Enhancement Measures

Enhancement measures have already been provided.

Significance Statement

With appropriate enhancement, the cumulative impact of the project should have a high positive impact in terms of generating expendable incomes in the PACs. Without appropriate enhancement, the cumulative impact of the project should still have a high positive impact in terms of generating expendable incomes in the PACs.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Cumulative Phase					
Without Enhancement	Long-Term	Regional	Beneficial	Definite	**HIGH +**
With Enhancement	Long-Term	Regional	Beneficial	Probable	**HIGH +**

Impact 1.2: Improved Access to Social Services

Cause and Comment

It is believed that general access to social services should increase due to an increase in the PACs' expendable income.

Enhancement Measures

Enhancement measures have already been provided.

Significance Statement

With appropriate enhancement, the cumulative impact of the project should have a high positive impact in terms of increasing access to social services in the PACs. Without appropriate enhancement, the cumulative impact of the project should still have a high positive impact in terms of increasing access to social services for the PACs.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Cumulative Phase					
Without Enhancement	Long-Term	Regional	Beneficial	Definite	**HIGH +**
With Enhancement	Long-Term	Regional	Beneficial	Probable	**HIGH +**

Impact 1.3: Increased Tourism Activities

Cause and Comment

It is believed that the project could stimulate tourism activities. This impact has already been discussed. There are no significant changes in the overall significance during the cumulative phase.

Issue 2: Health and Safety

The following health and safety related impacts are expected as cumulative impacts:

- Impact 2.1: Increased Spread of Disease;
- Impact 2.2: Increased Road Accidents:
- Impact 2.3: Increase in Dust;
- Impact 2.4: Fire Hazard;
- Impact 2.5: Increased Criminal Activity.

Impact 2.1: Increased Spread of Diseases

Cause and Comment

Numerous cumulative impacts exist as a result of the spread of disease. In the case of HIV/AIDS, the long-term impacts include a reduced and inefficient work force leading to lower household income security and greater poverty. The number of child- and elderly-headed households may increase, making access to education problematic as other responsibilities take priority. There is also likely to be an increased financial burden on the State as dependency increases. In the case of other diseases, the effect is more immediate. Project deadlines may be delayed due to unhealthy workers while the spread of water borne diseases in local communities could lead to possible pandemics. These impacts are, however, not thought to be significant for the proposed project.

The overall significance or this impact remains unchanged.

Impact 2.2: Increased Road Accidents

Cause and Comment

This impact has been discussed. It is believed that cumulative development could increase the area's traffic volumes, which could increase the possibility of general road accidents or make the roads unsafe for pedestrians.

Mitigation Measures

Mitigation measures have already been provided.

Significance Statement

Even with mitigation measures in place, this impact would still have a high negative significance. Should no mitigation measures be in place, this impact would still have a high negative overall significance, but the risk of the event occurring would be far greater.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Cumulative Phase					
Without Mitigation	Long-Term	Regional	Severe	Definite	**HIGH -**
With Mitigation	Long-Term	Regional	Severe	Definite	**HIGH -**

Impact 2.3: Increase in Dust

Cause and Comment

This impact has been discussed.

Mitigation Measures

Mitigation measures have already been provided.

Significance Statement

Should sufficient mitigation measure be in place, this impact would have a low negative overall significance. Should no mitigation measure be in place, this impact would have a moderate negative overall significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Cumulative Phase					
Without Mitigation	Long-Term	Local	Moderate	Probable	**MED -**
With Mitigation	Long-Term	Local	Slight	Probable	**LOW -**

Impact 2.4: Fire Hazard

Cause and Comment

This impact has been discussed. The overall significance of this impact remains unchanged.

Impact 2.5: Increased Criminal Activity

Cause and Comment

This impact has been discussed. The overall significance of this impact remains unchanged.

Issue 3: Social Services

It is anticipated that the project could potentially increase the pressure on existing social infrastructure as an influx of workers into the area might be experienced. However, a positive impact of the project is the fact that it will improve energy supply in South Africa. Both these impacts are considered below.

Impact 3.1: Increased pressure on existing social infrastructure

Cause and Comment

This impact has been discussed. The overall significance of this impact remains unchanged.

Impact 3.2: Improved Energy Production

Cause and Comment

This impact has been discussed. The overall significance of this impact remains unchanged.

Issue 4: Cultural Heritage

Cumulative development in the area could affect the area's cultural heritage. The impact discussed under this issue relates to this project's aesthetic impact on the area.

Impact 4.1: Aesthetic Impact

Cause and Comment

Cumulative development might affect the area from an aesthetic perspective, which could also influence negatively the area's tourism activities. For example, if people's general sense of place has been altered by cumulative development, the AFNP may experience a reduction in tourism.

The overall significance of this impact remains unchanged.

7.6.8 Visual

Impact: The potential contribution of the project infrastructure to the increase of similar developments within the region.

Cause and comment

The development of other hydro-power stations on the Orange River.

Mitigation and management

These are described under the construction and operation phases.

Significance statement

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Without Mitigation	Long term	Regional	Moderate	Probable	**MODERATE**
With Mitigation	Long term	Regional	Moderate	Probable	**LOW**

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary and Key Findings of the EIA

In light of South Africa's current electricity crisis, as well as clear indications that demand for electricity will continue to exceed reliable generating capacity in the medium- to long-term, there is an urgent need for new generation capacity. The Renewable Energy Independent Power Producer Procurement Program (REIPPPP) is evidence of Government's desire to harness renewable energy, diversify the sources of power, and engage private industry in solving South Africa's energy needs. The choice of location of this particular project is however, a matter of conflict for various parties. Certainly the characteristics of the particular site make it highly suitable for the development of a run-of-river hydroelectric scheme, but the site also conserves and protects a unique South African landscape. The Augrabies Falls National Park (AFNP) has been in existence since 1966. The park's internal zoning plans classify the portion of the project site to be developed as both "Remote" and "Primitive", which are the highest forms of protection provided to any areas managed by SANParks. However, sites for run-of-river HPPs are few and need to be optimised.

In brief, the specialist studies conducted for the project have made the following conclusions.

Agriculture

The site is not currently used for agriculture, but is conserved by SANParks. Therefore, there will be no impacts on agriculture. The agricultural potential of the site is low in any event, with most of the site having classifications of Class 7 - *non-arable* and Class 8 - *non-utilisable wilderness.* The position of the dump site for surplus excavated material and the project's 132 kV overhead line to its connection point with Eskom's 132 kV line connecting Blouputs and Renosterkop substations will, however, be located outside of the Park and have the potential to impact on agricultural activities currently being undertaken in the affected areas. However, it is likely these impacts can be mitigated by proper placement of these components during the detailed design phase, in consultation with affected landowners and an agricultural expert.

Aquatic Ecology

The river has already been affected by manipulations of the quantity and seasonality of the flow regime by large upstream impoundments and abstractions for irrigated agriculture. The water quality regime has been affected by irrigation return flows and to a lesser extent by mining effluents. However, the Present Ecological State is assessed as Category C - Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. The analysis rated the Ecological Sensitivity of the system as High. The diversion of water from the river into the hydropower station will be done in such a way that the impacts on the Augrabies Falls, and the gorge downstream of the falls is considered to be low, both from a visual perspective as well as in terms of the ecological functioning of the river. It is recommended that fish passage facilities be built into the weir, which has in any case become a standard requirement from the Department of Water and Sanitation. Impacts on the secondary channel downstream of the weir can be easily mitigated by controlling erosion during excavation for the headrace. The introduction of more regular flow into the palaeo gorge downstream of the tailrace outfall is considered to be a positive impact by developing additional aquatic habitat in an area that receives flow only episodically during exceptionally high flood events.

Vegetation

The Riemvasmaak study area is not botanically sensitive in a broad sense and apart from Lower Gariep Alluvial Vegetation, the flora and vegetation are not threatened. However, the environment is well conserved and is distinctly wilderness. The low sensitivity of the vegetation should, however, not be interpreted as providing a licence to negatively impact the environment. The ecosystem is largely intact and undisturbed. Any development must therefore be cognisant of this sensitive environment.

Fauna

The Northern Cape Province has a relatively low faunal diversity, particularly for aquatic species and large mammal herbivores. However, many desert-adapted reptiles and birds are endemic or near-endemic to the region. Amphibians are the least specious group of terrestrial vertebrates in the project area. Reptile diversity in and around the study area is high, with over 50 species known or likely to occur. The Nama Karoo supports a particularly high diversity of bird species endemic to southern Africa, and characteristically comprises species of open habitats, particularly larks. Much of the historical large mammal fauna in the region has been greatly reduced or even eliminated.

The project area remains relatively natural due to its recent history of management by the AFNP. The riparian vegetation is also largely intact, unlike that in upstream regions where it has largely been replaced by irrigated cultivation. The project area is contiguous with, and currently managed by, the adjacent AFNP, which is also one of the 122 Important Bird Areas in South Africa. It retains significant components of Nama Karoo biodiversity, and due to its proximity to the AFNP forms an important component of the protection of this biome.

Reptile diversity in the region is much greater, with 57 species known in the region. Two lizards are Near Endemic to the region, but no reptiles of conservation concern are present. The most sensitive habitats for reptiles are expansive rocky areas, particularly in the 'Canyon Zone'.

Although 247 bird species have been recorded for AFNP, many of these are of seasonal, irregular or vagrant occurrence. Only 111 species were recorded during the survey. Fourteen (14) birds of conservation concern are recorded in the region, whilst 15 species are near endemic or are range or biome-restricted species. The most significant avian SCC recorded in the region are Kori Bustard (VU), Black Stork (NT), Openbill Stork (NT), Lanner Falcon (NT), Rosy-faced Lovebird (NE), Karoo Lark (NE), Karoo Long-billed Lark (NE), Black-eared Sparrowlark (NE) and Namaqua Warbler (NE). The most sensitive habitat for birds is the riparian vegetation along the Orange River and its palaeochannels.

Large mammals are no longer a feature of Northern Cape landscapes, except in protected areas. In 2012, 150 head of game (mainly Springbok, Gemsbok and Eland) occurred in the Riemvasmaak region. The majority of mammals present are small to medium-sized, and the micromammal component in the region is much greater than indicated on the AFNP mammal checklist. Mammals use all habitats in the region, and the rock fissures and cracks of the Canyon region form roosts for large numbers of bats which play an important role in the control of insect pests over the irrigated agricultural lands, as well as control black fly pests that have a significant economic impact in the region.

There are few SSC for all faunal groups in the region, and most are well protected in the AFNP. The use of the Riemvasmaak as a Hook-Lipped Rhinoceros refuge is no longer viable for security reasons, but the area presents suitable habitat for this species.

Rocky outcrops and cliffs in the 'Canyon Zone' of the Riemvasmaak region should be avoided as these are visually sensitive and also form important habitat for rupicolous lizards, birds, and the Marbled Rubber Frog.

The riverine habitats at the weir site, and in the palaeo channels of the Orange River, form sensitive wetland habitats, and important habitats for amphibians and birds, and drinking points for large mammals.

The upper 'palaeochannel' forms a significant ecological corridor of High sensitivity. The route of the proposed water conduit runs in very close proximity to the right edge of this drainage line.

Heritage

Given the igneous rocks of which the landscape is comprised, palaeontological material would not

occur in the area's hard geology. However, it is possible that isolated fossils might be present trapped within the silt deposits on the Orange River floodplains. These would most likely comprise tiny plant and animal remains.

A wide variety of heritage resources was recorded. These included scatters of Middle (MSA), and Later Stone Age (LSA) and historical artefacts, LSA occupation sites with deposits and historical occupation sites with ruined structures and artefacts of varying age. Significantly, a number of graves and many more stone features that may or may not be graves were located. A stone memorial was also found. All the historical features together comprise a relatively recent (20th century) cultural landscape but it should be noted that the community who created that landscape have given permission for the development to proceed. This serves to temper the significance of the cultural landscape and individual features of which it is comprised.

Noise

Daytime noise levels associated with construction activities are expected to be limited to an area within 500 metres from the activity. The nature of the noise is generally more impulsive and in a sensitive natural environment animals will try to relocate further from the noise source. The information available is adequate to conclude that there will be a low potential for a noise impact during the construction phase due to the large distance between receptors and construction areas (project footprint and construction road traffic noise). There is a low potential of a noise impact during the construction of the over-head power lines, especially when this work takes place within 500 meters from potential noise-sensitive developments. Noise associated with the operational phase is considered to be very low, because the hydro-power generation equipment, a single point noise contributor, is to be located underground, resulting in a significant reduction in the noise levels and the extent of the potential noise impact.

Considering the worse-case scenario, due to the fact that the equipment will be situated inside a building buried deep underground the potential of a noise impact is minimal. The criteria as set out in the SANS10328:2008 guidelines indicate a low potential for a noise impact during operations and that no further acoustical studies will be required.

Overall, this assessment could not identify human receptors living within 2 000 metres from the proposed development.

Socio-economic and Tourism

The project is being developed on a piece of land held collectively under the Riemvasmaak Community Development Trust (RCDT). The route alignment of project infrastructure has been designed to avoid all identified graves. The community trust land has a unique cultural heritage value in South Africa, as it was the first land restitution case completed after 1994. The Project-Affected Communities (PACs), and the areas from which the majority of the local labour will be sourced, include the town of Augrabies in the Northern Cape.

The project is anticipated to provide between 150 and 200 temporary opportunities during the construction phase, whilst between five and ten permanent opportunities will be created during the project's operational phase. Most of the opportunities will be afforded to the surrounding communities, which should increase the general wages of some households during the construction phase. This should impact positively on the local economy, as the disposable income will be increased.

A key finding from the SIA is that members of the local communities, ward councillors and local government officials highlighted what they believe to be a concerning issue of unemployment and few employment opportunities in the region. These are seen as challenges faced by the area's communities which deserve attention.

The ZF Mgcawu DM has various tourism attractions, in particular, national parks and reserves. The Kgalagadi Transfrontier Park, the Spitskop Nature Reserve and the Augrabies Falls National Park

are all found within the district. Other opportunities are based around eco-tourism, such as 4x4 trails, camping, etc.

The Augrabies Falls is a significant tourist draw card in the region, with 84,627 visitors in 2010, 83,970 visitors in 2011, 58,066 visitor in 2012 and 36,885 visitors between January and August 2013 (AFNP Booking Records). It should, however, be noted that flooding in 2010 and 2011 skewed the figures as people flocked to AFNP to see the falls in flood conditions. The proposed project will have no impact on flood conditions over the Augrabies Falls.

The main attraction within the reserve is the Augrabies Falls itself, a 56 m high waterfall with various viewing decks and the park reception in near vicinity. The river then continues its path through an 18 km gorge. Two hiking trails exist with the longer, 3 day trail being closed during October to May due to the heat. Mountain biking and game driving also take place within the park. Several panoramic viewpoints can be visited inside the park, all of which give wide open vistas of the park, the gorge and the Orange River. These viewpoints are Moon Rock (offering one of the best views of the Park and surrounds), Swart Rante, Oranjekom and Ararat (offering the best opportunity to observe the massive gorge area) and Echo Corner (Urban-Econ, 2012). In addition to these activities 'Kalahari Outventures' offers white water rafting trips which take place above the falls and canoe trails which take place below the falls.

Changes to the sense of place which may impact negatively on tourism in the area are impacts on the aesthetic nature of the area and an increase in noise and dust associated with construction activities. The natural beauty of the area, virtually no 'unnatural' noise and the general 'peace and tranquillity' associated with the AFNP are significant attractions for tourists visiting the park as well as for people rafting, paddling or fishing on/in the river. This was confirmed with findings from questionnaires conducted with tourists. There is the possibility that if the visual and noise impacts are not properly mitigated during construction there may be an impact on the sense of place. This in turn will negatively impact the experience of tourists to the park which will reduce the possibility of them returning or reporting favourably on their experience at AFNP. Cumulatively this could impact on the number of tourists visiting the park. That said, with sufficient mitigation measures the overall experience for tourists visiting the park should not be significantly affected.

While a minimum of 30m³/s will always be channelled to the falls, provided the flow of the river is not below this level, there will always be a slight reduction in the amount of water reaching the falls when the river is flowing above 30m³/s. The issue of reduced flow and the impact it may have on tourism for the park and tourists' experience of the falls was identified by representatives of the AFNP, who noted the importance of the falls in attracting tourists. In an effort to gauge the importance of the volume of water flowing over the falls on the number of visitors to the park, visitor data from March 2009 to August 2013 were compared with flow data for the same period.

Data from February 2010 and January 2011 show that, during times of very high flow, the number of visitors to the park increases significantly, suggesting a direct correlation between the level of flow and the number of visitors to AFNP. However, it needs to be noted that at these particular times the Orange River was in flood.

From September 2011 to August 2013, while the flow has remained relatively consistent, there have still been noticeable spikes in visitors to the park around the August and September periods, probably caused by tourists en route to Namaqualand, and December and January, a peak holiday period. The increase in tourists during these times can also be seen in 2009 and 2010. These findings suggest that while there is likely to be a large influx of tourists during times of flood, generally the number of visitors to the Park is not solely determined by the volume of water over the falls.

In addition, the amount of water being channelled to the proposed hydroelectric scheme will be proportional to the total volume of water in the river, but will never exceed 38m³/s. It is suggested that the proportion by which the flow over the Augrabies Falls will be reduced at any given flow will not be noticeable to the viewer and, as such, will not reduce the visitor experience. White water

rafting activities, conducted by 'Kalahari Outventures', take place above the falls and, as such, a reduction in flow will not have a significant impact on these activities. In the case of the canoe trails which take place below the falls, it is anticipated that water would have been diverted back into the river above where the canoe trails start and, as such, no impact will be felt.

There are many examples of tourism being stimulated through the presence of hydropower plants. Even though issues of tourism are usually taken into consideration during construction, there are many instances of favourable factors emerging indirectly in the course of time. Guided tours of power plants and information centres attract numerous visitors, who also make use of other tourist facilities in the immediate area.

During discussions with a tourism consultant based in the Northern Cape who has extensive knowledge of the project area and tourism within the area, it was noted that there is potential for the proposed hydropower scheme to be used to generate tourism. It was added that such an opportunity needs to be considered early in the design phase, as infrastructure, such as viewing decks, would contribute to the marketability of the scheme as a tourism attraction (Mr Page, Personal Communication). In the event of the scheme being used as a tourism attraction, various spinoff opportunities arise, such as employment opportunities for tour guides which will assist the local communities. In addition, it was noted by representatives of the Riemvasmaak Tourism Association and representatives of the AFNP that there are plans to extend tourism into the northern sections of the AFNP. The plan to extend tourism to this section of the park could benefit from improved access to the area created by the installation of the hydropower scheme. However, the good access will reduce the potential of the area as a 4x4 tourism route (a possible option suggested by the Riemvasmaak Tourism Association) while the presence of artificial lights, even if only activated by motion sensors, will limit the attractiveness of the area as an ecotourism destination. Sensible placement of lights will serve to mitigate this. Lastly, it should be noted that from questionnaires completed by visitors to the AFNP, the majority of respondents reported that they did not consider a tour of a hydropower station as a tourist opportunity and, thus, did not see it as contributing to tourism for the area as a whole.

Visual

The land on which all project infrastructure is located is zoned in the AFNP's Management Plan 2013-2023 as both "Primitive" and "Remote". The project infrastructure also falls within the priority natural areas buffer, as well as the viewshed protection areas.

The purpose of the park zoning is, "*To establish a coherent spatial framework in and around a park to guide and co-ordinate conservation, tourism and visitor experience initiatives*" (AFNP, 2013). The zoning of AFNP was based on an analysis and mapping of the sensitivity and value of the park's biophysical, heritage and scenic resources; an assessment of the regional context; and an assessment of the Park's current and planned infrastructure and tourist routes / products; all interpreted in the context of Park objectives.

The Remote zone's characteristics are summarised as: "*Retains an intrinsically wild appearance and character, or capable of being restored to such*", where the experience should be one of solitude and awe inspiring natural characteristics. The aesthetic and recreational conservation objective for this zone is: "*The area should be kept in a natural state, and activities which impact on the intrinsically wild appearance and character of the area, or which impact on the wilderness characteristics of the area (solitude, remoteness, wildness, serenity, peace etc.) should not be allowed*".

The Primitive zone should "*generally retain its wilderness qualities, but with basic self-catering facilities (concession facilities may be more sophisticated). Access is controlled. Provides access to the Remote Zone, and can serve as a buffer*". This zone is suitable for small, basic, self-catering; or limited concessions with limited numbers (concession facilities may be more sophisticated); for 4x4 trails and hiking trails.

The affected environment from a visual perspective is as follows: the towns of Augrabies (13.8 km

from nearest edge of town to infrastructure located furthest away (tailrace and outfall); 3.8 km from nearest edge of town to infrastructure located closest (132 kV overhead line), Witklip, and Rooipad lie to the south of the AFNP and are the nearest urban areas to the project infrastructure. Settlements and homesteads are limited in number, and clustered along the secondary roads. The very limited large-scale electricity and industrial infrastructure within the region includes the Renosterkop Substation in the south east and the Blouputs to Renosterkop 132kV power line. The vegetation of the area is sparse, and therefore will not assist to block views of the project infrastructure.

If most infrastructure is buried as planned, the visual exposure will be most significant during the construction phase. However, certain infrastructure components will be visible throughout the project's existence, namely: the weir and offtake structure, the spoil heaps, the substation, and the 132 kV overhead line. The topography of the area is such that these features will not be visible from the viewing platforms for the falls, or from the area of the park's rest camp, and they are considered to be of low significance in the context of where they are located in the broader landscape. The power station headworks will also not be visible from the falls and rest camp, but will be visible from a distance of between 2.5 and 3 km from the high points (Moon Rock Ararat, Oranjekom, Echo Corner) on the left (west) bank of the Orange River.

Seismic activity

Work by the Council for Geoscience has identified and defined the occurrence of a recent earthquake swarm in the Augrabies area, which commenced in July 2010 and consisted of continual small seismic tremors. Up to the end of December 2014 the swarm has included 16 seismic events with magnitude of between 4.0 and 5.0 on the Richter scale. The area of occurrence of these larger tremors is an elongated belt 55 km long and 17 km wide, starting from south of Kakamas and extending in a north-northwesterly direction continuing roughly parallel to the course of the Orange River and up to roughly 6 km north of the site of the proposed hydropower project. However, if all smaller tremors are included the area of occurrence is much larger, with a footprint approximately 290km long by 65 km wide, elongated in the same direction.

No events of magnitude equal to or greater than 3.0 have occurred since 2012, and not a single event exceeding a magnitude of 5.0 (approximately Modified Mercalli intensity scale VI) has occurred during the currency of the swarm. Nevertheless, all structures will have to be designed to resist tremors at least equal to the maximum magnitude recorded during the swarm thus far.

It is considered highly unlikely that cavities could form, as the local geology is not conducive to the formation of cavities or sinkholes (it is not dolomitic terrain).

8.2 EAP's Recommendation

8.2.1 General recommendations

Section 31(n) of the NEMA Environmental Impact Assessment Regulations, 2010 - Environmental impact assessment reports – requires the EAP to provide "a reasoned opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation".

It is anticipated that many of the botanical and faunal impacts will be reduced with final engineering design being cognisant of the findings and sensitivities identified in this report, the effective management of the site during construction, as well as the utilisation of appropriate rehabilitation techniques after construction. Since most infrastructure will be underground, the land surface will be properly rehabilitated, and with time the evidence of the underground infrastructure will become increasingly difficult to detect, as is evidenced by the Drakensberg Pumped-Storage Hydroelectric power project.

There will be above-ground infrastructure evident after construction is completed. The weir will be a low structure and cannot be regarded as offensive, since for most of the time the spillway

sections will be overflowing with water, and only the flanking walls will be visible. Under all but the very low and very high flows canoeists and rafters travelling downstream will be able to negotiate the weir. The offtake works will be substantial, but with as sympathetic and careful architectural treatment as can be applied to a structure of this nature, and regrowth of the riparian vegetation disturbed by construction, the structure will become less and less obvious. There will be above-ground structures at the site of the head pond, including a power chamber access structure and a switchyard / substation. There is potential in this very remote area to position these features so as to limit visibility from all but the highest vantage points in the area, including the high points on the west side of the river (Moon Rock, Ararat and so on), albeit at distances of between 2.5 and 3 km. The site will not be visible from the rest camp in the park.

The transmission line from the power chamber will be underground until the eastern boundary of the farm 497/0 property fence line, which is also the boundary of the park, where a substation will be constructed, followed by above-ground lines to the southern side of the Orange River. Such infrastructure is not uncommon common in the area, and it will not necessarily have a noticeable visual effect on the area. The route of the overhead lines will be carefully selected, in consultation with Eskom and the landowners, to minimise impacts on agricultural activity along the route.

Recommendations that provisions to facilitate fish passage upstream over the weir, if studies should prove it necessary or if it is required by the Department of Water and Sanitation, together with regular monitoring of water quality, are appropriate mitigation measures to protect the aquatic environment during the operational phase. Discharge of water from the power chamber will augment the extent of aquatic habitat at the downstream end of the project. The minimum flow requirement of 30 cubic metres per second (cumecs) down the Augrabies Falls, which is entirely consonant with recommendations made in reports prepared for ORASECOM, will never be prejudiced by diversion of water to the hydropower project. In addition, the diversion of water into the project will be effected progressively as the flow rate in the river increases from 30 to 90 cumecs. It is highly unlikely that this will significantly diminish the visual spectacle of the falls, since it is difficult for the normal visitor to distinguish between flows between 30 and around 70 cumecs, and it will certainly not diminish the magnificence of the falls when they are in flood. Water diverted for use in the generation facility will be returned approximately 10km downstream of the falls, and the nature of the gorge along this reach is such that the available habitat is relatively unproductive compared with the reach immediately upstream of the falls, and the reduction of flow rates by 30 cumecs is not thought to have significant ecological impacts.

The potential impacts on the biological environment need to be considered in light of the positive socio-economic impacts that will result, not only to the Riemvasmaak community, the community trusts and the local population, but also with regards to stabilising the local supply of electricity, and augmenting South Africa's electricity supply. In addition, hydroelectric projects are able to supply baseload more consistently and for longer periods, than, say, solar or wind facilities.

We are not insensitive to the concerns expressed thus far by SANParks and the management of the Augrabies Falls National Park. We acknowledge that the construction of the project will need to be carried out with the utmost care, and if the mitigation measures proposed in this report are consistently and diligently implemented, we believe that this phase of the project can be undertaken with minimal inconvenience to the park and its visitors. This is especially so since access to the northern parts of the park has been limited to SANParks staff for a number of years, and the ordinary visitor will not be significantly inconvenienced by the project.

As discussed previously, when construction is completed and the site is rehabilitated, we are of the opinion that its influence on the park will be negligible. Its influence on the local population and the country as a whole will, however, be significantly positive. Accordingly we encourage SANParks to regard this project as being in the national interest, and not as a threat to the integrity of the Park.

Accordingly, under the conditions described in this report and the associated Draft Environmental Management Programme, we recommend that the project receive Environmental Authorisation in sufficient time for it to be considered in Round 5 of the Department of Energy's renewable energy

bidding process.

8.2.2 The Environmental Authorisation

Environmental Management Programme

All recommendations in the Environmental Management Programme (EMPr), submitted as part of this suite of reports as Volume 4, should be adhered to during the construction and operation phases of the project, and all recommended mitigation measures should be implemented.

A suitable qualified and experienced Environmental Control Officer (ECO) should be appointed for the entire period of construction to ensure that recommendations are implemented, and should have a full-time presence on the site during construction.

The following management plans should be prepared, within the framework of the Environmental Management Programme, for the construction and operation phases of the project to incorporate DEA conditions:

- Site-specific Construction Environmental Management Plan (CEMP).
- Site-specific Operational Environmental Management Plan (OEMP).

These plans must be approved by DEA prior to the commencement of construction or operational activities.

The plans should address all environmental and social issues associated with the project, including labour, and occupational health and safety issues, in accordance with the following issue-specific plans (listed in alphabetic order):

- Community Health and Safety Management Plan
- Emergency Diversion Shut-down Plan
- Emergency Preparedness and Management Plan
- Environmental & Social Monitoring Plan
- Hazardous Materials Management Plan
- Heritage Resources Management Plan
- Integrated Waste Management Plan
- Labour Recruitment and Procurement Management Plan
- Occupational Health and Safety Management Plan
- Roads and Transport Management Plan
- Security Management Plan
- Stormwater Management Plan

In addition, prior to the commencement of any construction it will be necessary to acquire:

- Permission to construct from South African National Parks;
- A Water Use Licence from DWS; and
- A servitude of aqueduct from the Department of Public Works.

Key Risks and mitigation measures

Although all recommendations and mitigation measures are important, there are a number of issues associated with the project that, because of the high sensitivity of the site and its surroundings, are considered to represent key risks to the project if they are not properly managed. These risks and their potential impacts should receive particular attention in the Environmental Authorisation.

During Construction:

- ❖ Maintain the flow of the Orange River past the site of the diversion weir and offtake structure at all times, without widening the river channel.
- ❖ Minimise blasting for the headrace, and at the diversion weir site blasting must be

restricted to the area confined within sealed coffer dams, with no connection to the water flowing in the river channel.

- Minimise removal of vegetation, especially Lower Gariep Alluvial Vegetation in the riparian zone at the site of the offtake structure.
- Demarcate a 30m-wide buffer zone around identified wetland areas and between the riparian zone of the Orange River and the secondary channel to the palaeo-falls, and maintain this zone free of any construction activity.
- Backfill excavations for the headrace as soon as practically possible, concomitant with maintaining structural integrity, and commence rehabilitation of vegetation as soon as possible thereafter.
- Rehabilitate watercourses crossing the route of the headrace as soon as possible after backfilling, to restore their ability to drain water towards the Orange River.
- Minimise the size of the above-ground elements of access chambers to the headrace to reduce visual intrusion.
- Minimise the footprints of laydown areas and site offices to reduce visual intrusion.
- Establish and strictly enforce an absolute prohibition of anyone on the site interfering in any way with fauna and flora of any sort, and impose severe penalties for transgression.
- Implement compulsory awareness creation for everyone who works on or visits the site, in whatever capacity, via the Environmental Awareness Programme, and ensure that the behavioural requirements are regularly and frequently repeated to the workforce during day-to-day refresher discussions/toolbox talks.
- Address the potential general nuisance of construction to AFNP staff and tourists by:
  - Adhering strictly to agreed working hours,
  - Minimising driving during the hours of darkness,
  - Adhering strictly to speed limits and imposing penalties for transgression,
  - Minimising the generation of dust,
  - Minimising construction noise.

During Operation:

- Adhere strictly to the agreed minimum flow rate in the Orange River at which diversion of flow to the power station may commence, and adhere to any Conditions attached to the Water Use Licence.
- Adhere strictly to the agreed schedule for increasing the diversion of flow to the power station up to the maximum rate of diversion.
- Establish and implement, in conjunction with SANParks staff, an emergency shutdown procedure for the diversion of flow to the power station.
- Monitor the effectiveness of vegetation rehabilitation for a period of at least four years, or until it is clear that vegetation has successfully re-established itself.
- Ensure that the routine operation of the project, or maintenance work on the project, does not significantly impact the activities of AFNP staff or the experience of tourists, by minimising visual intrusion, and the generation of dust and noise.
- Regularly monitor the spoil site and maintain it in an aesthetically pleasing condition.

Decommissioning

Since the facility will be strategically important to South Africa the likelihood of it being decommissioned is at least 50 years hence, probably more, no plan has been proposed for decommissioning. Conditions to address the circumstances and relevant legislation prevailing at that time should be developed when decommissioning is being considered.

REFERENCES

ACER (Africa) Environmental Management Consultants, January 2014. Socio-economic Impact Assessment, Specialist Study Report (Revision 1).

Alexander, G. and Marais, J. 2010. *A Guide to Reptiles of Southern Africa*. Struik Nature, Cape Town.

Alexander, G.J., Horne, D. & Hanrahan, S.A. 2002. An evaluation of the effects of deltamethrin on two non-target lizard species in the Karoo, South Africa. Journal of Arid Environments. 50(1):121–133.

Anderson, M.D. 2000. Raptor conservation in the Northern Cape Province, South Africa. Ostrich 71: 25-32.

Animal Demography Unit, Department Of Zoology, University Of Cape Town. 2012. *Summary Data Of The Frogs Of South Africa, Lesotho And Swaziland.* Downloaded From: Http://Adu.Org.Za/Frog_Atlas.Php; Accessed On 05/03/2015.

Augrabies Falls National Park Management Plan 2013-2023. South African National Parks report, 81p. Downloaded 5 February 2015 from: Aurecon. 2013. Proposed Hydropower Station on the Farm Riemvasmaak (Remainder of Farm no. 497 and Portion of Farm no. 498), on the Orange River in the Vicinity of Augrabies, Northern Cape: Draft Scoping Report: Report No. 8177.

Avery, D.M. & Avery, G. 2011. Micromammals in the Northern Cape Province of South Africa, past and present. African Natural History 7: 9-39.

Avian Power Line Interaction Committee (APLIC). 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute and APLIC. Washington, D.C.

Barnes, K. N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. Birdlife South Africa.

Barnes, K.N. & Anderson, M.D. 1998. Important Bird Areas of the Northern Cape. In: The Important Birds Areas of southern Africa. Barnes, K.N. (ed.) pp. 103-122. BirdLife South Africa, Johannesburg.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & de Villiers, M. (eds.) 2013. *Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute, Pretoria (in press).

Bauer, A.M. & Branch, W.R. 2001 (2003). The herpetofauna of the Richterveld National Park and the adjacent northern Richtersveld, Northern Cape Province, Republic of South Africa. Herpetol. Nat. Hist. 8(2): 111-160.

Bauer, A.M., Barts, M. & Hulbert, F. 2006b A new species of the *Pachydactylus weberi* group (Reptilia: Squamata: Gekkonidae) from the Orange River, with comments on its natural history. Salamandra 42: 83-92.

Bauer, A.M., Lamb, T, & Branch, W.R. 2006a A revision of the *Pachydactylus serval* and *P. weberi* groups (Reptilia: Squamata: Gekkonidae) of Southern Africa, with the description of eight new species. Proc. Cal. Acad. Sci.: 57: 595-709.

BirdLife International. 2013. Country profile: South Africa. Available from: http://www.birdlife.org/datazone/country/south-africa. Checked: 2013-03-04

Blaustein, A. R. and D. B. Wake. 1990. Declining amphibian populations - a global phenomenon. Trends in Ecology & Evolution 5:203-204.

Böhm, M., Collen, B., Baillie, J.E.M., Bowles, P., et al. 2013. The conservation status of the world's reptiles. Biological Conservation 157: 372-385.

Branch, B. 2008. *Tortoises, Terrapins and Turtles of Africa*. Struik Publishers, Cape Town, 128pp.

Branch, W.R. 1998. *Field Guide to the Snakes and other Reptiles of Southern Africa*. Rev. ed. Struik Publ., Cape Town, 399pp.

Branch, W.R. 2014. Reptiles of South Africa, Lesotho and Swaziland: Conservation status, diversity, endemism, hotspots and threats. Pp. 22-44. In: Atlas and Red Data Book of the Reptiles of South Africa, Lesotho and Swaziland. Eds: M.F. Bates, W.R. Branch, A.M. Bauer, M. Burger, J. Marais, G.J. Alexander & M.S. de Villiers. Strelitzia 32, South African National Biodiversity Institute, Pretoria

Burger, M. and W. R. Branch, 1994. Tortoise mortality caused by electrified fences in the Thomas Baines Nature Reserve, Eastern Cape. S. Afr. J. Wildl. Res. 24(1/2): 32-37.

Channing, A. & Baptista, N. 2013. *Amietia angolensis* and *A. fuscigula* (Anura: Pyxicephalidae) in southern Africa: A cold case reheated. Zootaxa 3640(4): 501-520.

Channing, A. 2001. *Amphibians of Central and Southern Africa*. Ithaca. Cornell University press, 470 pp.

Cohen, C., Spottiswoode, C. & Rossouw,J. 2006. Southern African Birdfinder: Where to find 1 400 bird species in southern Africa and Madacascar. Struik Publishers, Cape Town.

Council for Geoscience 2015: Desktop Geotechnical Investigation for the Proposed Riemvasmaak Hydro Electric Power Facility in the Augrabies-Riemvasmaak Area, Farm Riemvasmaak (497/0 And 498/1), Augrabies Falls National Park. Council for Geoscience, Project No. CO2015-5778 (Phase 45), 6th February 2015

Dean, W.R.J., and S.J. Milton. 1999. Animal foraging and food. Pages 164-177 in W.R.J. Dean, and S.J. Milton, editors. The Karoo. Ecological patterns and processes. Cambridge University Press, Cambridge.

Du Preez, L.H. and Carruthers, V.C. 2009. A Complete Guide to the Frogs of Southern Africa. Struik Publ., Cape Town, 488pp

Du Preez, L.H. and Carruthers, V.C. 2009. *A Complete Guide to the Frogs of Southern Africa.* Struik Publ., Cape Town, 488pp

DWAF 2004: National Water Resource Strategy, First Edition, September 2004, Department of Water Affairs and Forestry, Pretoria (Appendices D13 & D14, Upper & Lower Orange Water Management Areas)

Eberhard, A., Kolker, J., Leigland, J. 2014. South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons. Public-Private Infrastructure Advisory Facility (PPIAF).

Ferraro, P.J. & Hanauer, M.M. 2015. Quantifying causal mechanisms to determine how protected areas affect poverty through changes in ecosystem services and infrastructure. PNAS Online Early Edition for the week of Feb 24-Feb 28, 2014 www.pnas.org/cgi/doi/10.1073/pnas.1307712111.

Friedmann, Y. & Daly, B. (eds.) 2004. *Red data book of the mammals of South Africa: a conservation assessment.* Johannesburg, CBSG-EWT, 722p.

Frost, Darrel R. 2014. *Amphibian Species of the World: an Online Reference*. Version 5.6 (accessed 9 February 2015). Electronic Database accessible at American Museum of Natural History, New York, USA. (http://research.amnh.org/herpetology/amphibia/index.html).

Heath, R & Brown, C. 2007. Orange River Integrated Water Resources Management Plan. Environmental Considerations Pertaining to the Orange River. Unpubl. Report, WRP Consulting Engineers, Jeffares and Green, Sechaba Consulting, WCE Pty Ltd, Water Surveys Botswana (Pty) Ltd, 190p.

Hockey, P.A.R., Dean, W.R.J. & Ryan, P.G. (eds.) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.

Hoffman, M. T. & Rhode, R. F. 2006. From pastoralism to tourism: The historical impact of changing land use practices in Namaqualand. Journal of Arid Environments 70 (2007) 641–658
http://www.sanparks.co.za/assets/docs/conservation/park_man/augrabies_approved_plan.pdf

Imani 2016: Proposed Hydropower Station on the Farm Riemvasmaak (Remainder of Farm No. 497 and Portion of Farm No. 498) on the Orange River, Northern Cape, Economic Impact Assessment, Specialist Study Report, Imani Development (SA) (Pty) Ltd, Umhlanga Rocks, February 2016.
IUCN (2012). Red List of Threatened Species. IUCN Species Survival Commission, Cambridge Available: http://www.iucnredlist.org/ (Accessed 05/03/2015).

IUCN 2014. IUCN Red List of Threatened Species. Version 2014.2. <www.iucnredlist.org>. Downloaded on 04 February 2015. Reviewed on 09 June 2016.

Jenkins, A. & Smallie, J. 2009. Terminal velocity: end of the line for Ludwig's Bustard? Africa - Birds & Birding 14(2):34-39.

Jenkins, A.R., De Goede, K.H., Sebele, L. & Diamond, M. 2013 Brokering a settlement between eagles and industry: sustainable management of large raptors nesting on power infrastructure. Bird Conservation International, 23, pp 232-246

Jenkins, A.R., Shaw, J.M., Smallie, J.J., Gibbons, B., Visagie, R. & Ryan, P.G. 2011. Estimating the impacts of power line collisions on Ludwig's Bustards *Neotis ludwigii*. Bird Conservation International 21:303-310.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 303-310.

Kingdon, J. 1997. *The Kingdon field guide to African mammals.* Academic Press Ltd, London.

Lloyd, J.W. 1999. Nama Karoo. Pages 84-93 in J. Knobel, editor. The magnificent natural heritage of South Africa. Sunbird Publishing, Cape Town, South Africa.

Lovegrove, B. 1993. *The living deserts of southern Africa.* Fernwood Press, Cape Town.

Martin, G.R. & Shaw, J.M. 2010. Bird collisions with power lines: failing to see the way ahead? Biological Conservation 143:2695-2702.

McDonald, D.J. 2012. Botanical Assessment for Riemvasmaak Hydro-power Project, Northern Cape Province. Unpub. Rpt. Prepared for Aurecon South Africa (Pty) Ltd., 66p.

Measey, G. J. & Davis, S.J. 2011. Struggling against domestic exotics at the southern end of Africa. Froglog 97: 28-30.

Measey, G. J. (ed.). 2011. Ensuring a future for South Africa's Frogs: A strategy for conservation research. *SANBI Biodiversity Series:* 19. South African National Biodiversity Institute, Pretoria.

Minter, L., M. Burger., J. Harrison, H. Braack, P. Bishop and D. Kloepfer (eds.) 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. *SI/MAB Series #9.* Smithsonian Institution, Washington, DC.

Mucina, L. & Rutherford, M.C. (eds) 2006. *The vegetation of South Africa, Lesotho and Swaziland.* Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Mucina, L. & Rutherford, M.C. (eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria

Mucina, L., Rutherford, M.C., Palmer, A.R., Milton, S.J., Scott, L. Lloyd, J.W., Van der Merwe, B., Hoare, D.B., Bezuidenhout, H., Vlok, J.H.J., Euston-Brown, D.I.W., Powrie, L.W. and Dold, A.P. 2006. Chapter 7: Nama Karoo Biome, In: Mucina, L. & Rutherford, M.C. 2006. (eds.) The Vegetation of South Africa. Lesotho & Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Myburgh, E. & Nevill, E.M., 2003. Review of blackfly (Diptera: Simuliidae) control in South Africa. Ondersterpoort J. Veter. Res. 70: 307-317.

Namakwa District Biodiversity Sector Plan (NDBSP). 2008. Namakwa Bioregional Plan, Northern Cape. pp 146.

NPAES 2011. BGIS LUDS Northern Cape: National Protected Area Expansion Strategy 2008 [online]. Available from http://bgisviewer.sanbi.org/BGISLUDS-SL-Viewer/Viewer.html?Viewer=National%20protected%20areas&layerTheme=NPAES%20focus%20areas [Accessed 20 April 2015].

ORASECOM 2007a: Review of Surface Hydrology in the Orange River Catchment, WRP Consulting

Engineers *et a*l, ORASECOM Report No 002/2007, November 2007

ORASECOM 2007b: Summary of Water Requirements from the Orange River, WRP Consulting Engineers *et al*, ORASECOM Report No 006/2007, November 2007

ORASECOM 2010: Environmental Flow requirements Volume 1, Updated August 2010, Louw & Koekemoer (Eds), Support to Phase 2 of ORASECOM Basin-wide IWRM Plan

Palmer, R.W. 1993. Short-term impacts of formulations of *Bacillus thuringiensis* var. *israelensis* de Barjac and the organophosphate temephs, used in blackfly (Diptera: Simuliidae) control, on rheophilic benthic macroinvertebrates in the middle Orange River, South Africa. Southern African Journal of Aquatic Sciences 19(1/2): 14-33.

Phillips, K., 1994. *Tracking the vanishing frogs*. Penguin Books, New York, 244. +

Pienaar, U. de V. 1977. *Phrynomerus annectens* (Werner), a rare frog in the Augrabies Falls National Park. Koedoe 20(1): 181.

Rutherford, M.C & Westfall, R.H. 1994. Biomes of southern Africa and objective categorization, Edn. 2. Mem. Bot. Surv. S. Afr. No. 63: 1-94.

SANParks, 2015. Climate: Augrabies Falls National Park. [Online]. Available: http://www.sanparks.co.za/parks/augrabies/tourism/climate.php [2015, 16 February].

Simmons, R.E. & Allan, D.G. 2002. The Orange River avifauna: abundance, richness and comparisons. Ostrich 73(1&2): 00–00.

Sinclair, I., Hockey, P., Ryan, P., Tarboton, W. 2011. Sasol Birds of Southern Africa IV. Struik Nature, Cape Town. 464 pp.

Skead, C.J., 1980. Historical Mammal Incidence in the Cape Province, Volume 1. The Western and Northern Cape. Cape Department of Nature and Environmental Conservation, Cape Town.
Sliwa, A. 2008. *Felis nigripes*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. <www.iucnredlist.org>. Downloaded on 05 February 2015.

Slabbert and Malherbe 1983: Die invloed van nate op die loop van die Oranjerivier in die omgewing van die Augrabiewaterval Nasionale Park. Slabbert, M.J. and Malherbe, S.J., 1983Koedoe 26, pp. 1-7.

Stuart, C and Stuart, T. 2007. A field guide to the mammals of Southern Africa. Struik Nature, Cape Town.

Stuart, C. and Stuart, M. 2001. Field Guide to Mammals of Southern Africa. Struik Publishers, Cape Town.

Tyler, N., Stokkan, K-A, Hogg, C., Nellemann, C., Vistnes, A-I. & Jeffery, G. 2014. Ultraviolet Vision and Avoidance of Power Lines in Birds and Mammals. Conservation Biology. DOI: 10.1111/cobi.12262.

UNESCO 2006. Statement of Inherant Value: Richtersveld [online]. Available from https://www.google.co.za/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=0CDMQFjAE&url=http%3A%2F%2Fwww.richtersveld-conservancy.org%2Fimages%2Fcontent%2Funesco_statement_of_value.pdf&ei=DNM0VbqNFoTfOJ5&usg=AFQjCNH7RhYRnZwY_T4yDZ_z1OS0sI52aA&sig2=UpEqDJy0oxXidgRU3rtEXQ&bvm=bv.9107109,d.ZGU [Accessed 20 April 2015].

Van Deventer, M. and J.A.J. Nel. 2006. Habitat, food, and small mammal community structure in Namaqualand. Koedoe 49(1): 99–109. Pretoria. ISSN 0075-6458.

Van Wyk, Abraham & Smith GF 2001. Regions of Floristic Endemism in Southern Africa: A review with emphasis on Succulents. Pretoria: Umdaus Press.

Werger, M.J.A. & B.J. Coetzee. 1977. A phytosociological and phytogeographical study of Augrabies Falls National Park, Republic of South Africa. Koedoe 20: 11-51.

Weinert 1980: The natural road construction materials of Southern Africa. National Institute for Transport and Road Research, CSIR, Pretoria, Weinert, H.H., 1980. pp. 36-39 and 56-59. National Book Printers.

Winterbottom, J.M. 1970. The Birds of the Augrabies Falls National park, Koedoe 13: 171-180.

APPENDICES

The Appendices are in a separate Volume - 3a.

APPENDIX	DESCRIPTION
A	Acceptance of Scoping Report and Approval of the Plan of Study for the EIA
B	Description of the Public Participation Process
C	Register of Interested and Affected Parties
D	Issues and Response Trail
E	Original Copies of Letters Received
F	Impact Rating Methodology
G	Land Ownership, Management and Zoning
H	SAHRA Review of HIA